SEPTEMBER • 1956

PETROLEUM REFINER

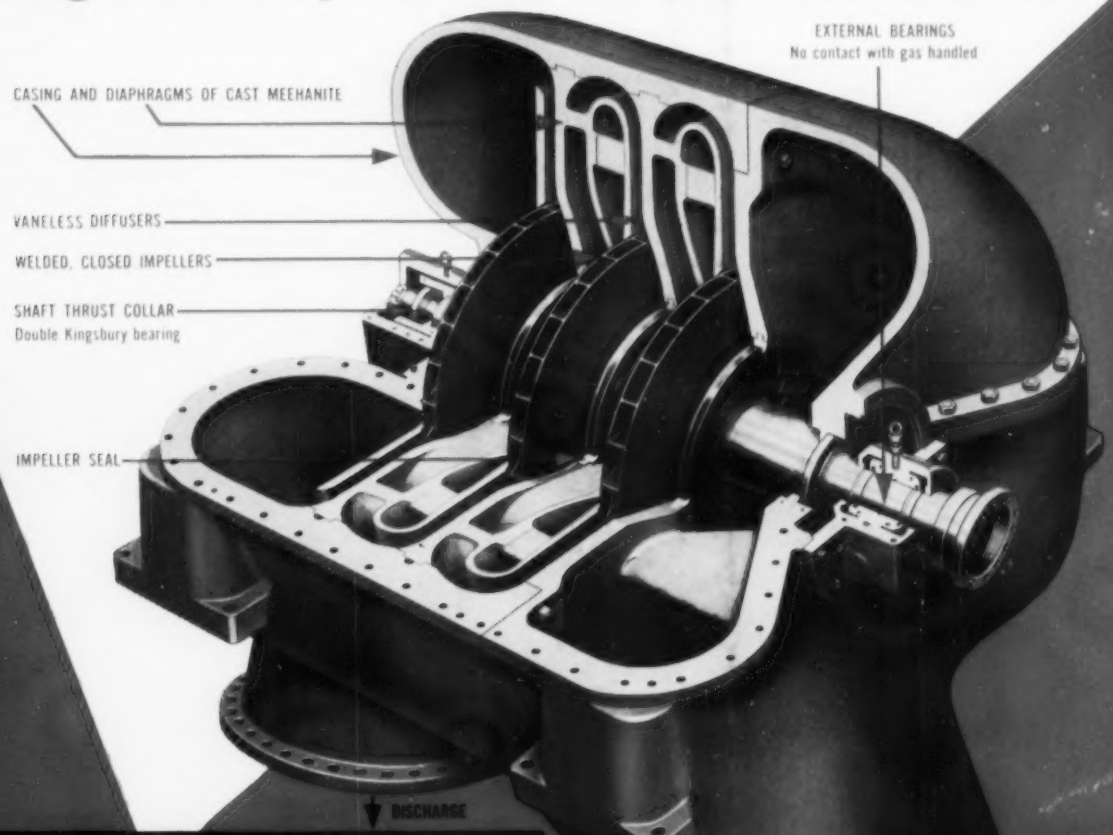
REFINING | PETROCHEMICALS | NATURAL GASOLINE

19th Process Handbook

plus

Hydrogen Treating—
What It Can Do

Pointing the way to non-stop performance



ELLIOTT CENTRIFUGAL COMPRESSORS

Take a good, close look at this Elliott Multistage Centrifugal Compressor. Note its simplicity and ruggedness of design and construction. It's easy to see why these compressors have been setting non-stop service records in refineries. They're built for the "long run."

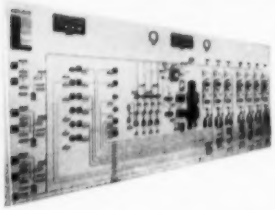
Elliott Centrifugal Compressors are available in both single and multistage types, for inlet capacities up to 175,000 cfm, and discharge pressures up to about 2000 psig. Drive may be turbine, gear-motor combination or direct-connected motor, all built by Elliott. For details write Elliott Company, Centrifugal Compressor Dept., Jeannette, Pa.

ELLIOTT Company

THE OCTANE EQUATION

TECHNICAL DATA

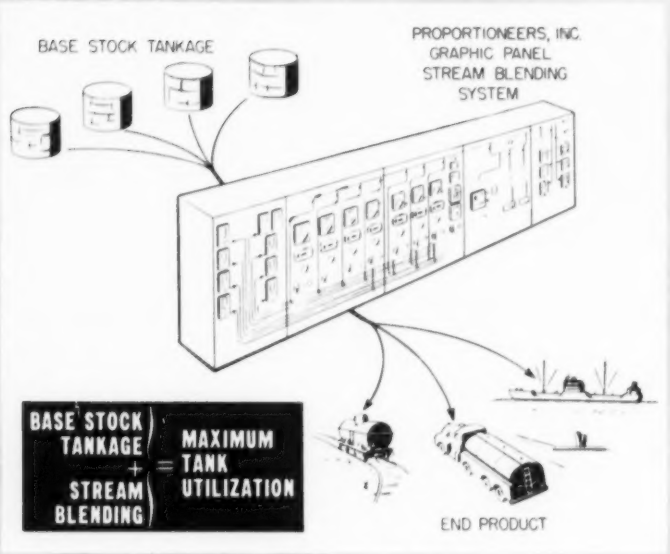
Shell Products Pipe Line was one of the first to recognize the flexibility of operation made possible by continuous automatic "stream" blending. This company has installed B-I-F Industries' equipment at their Wood River Pump Station for blending finished gasolines directly to their North and East lines respectively. Preset formulations at all flow rates of finished product demanded by the pipeline are automatically maintained by multiple component blenders . . . to blend six gasoline base stocks, T.E.L., dye, and gasoline additives to pipe lines without intermediate tankage. Full particulars on this installation are available



PROPORTIONEERS, INC. GRAPHIC PANEL STREAM BLENDING SYSTEM.

This equipment can be arranged to handle any type of problem and any number of components at flow rates ranging from 150 barrels per hour to the limit of modern transfer pumping equipment and pipe line sizes.

Units are available for stream blending other finished products (solvents, diesel fuels, lube oils, heating oils, bunker fuels, asphalt cut-backs, etc.) with equal facility and dependability. Our diversified product line . . . for metering, feeding and controlling any of the petroleum or petrochemical processes . . . is designed to make money for you. Let us show you how!



THE PROBLEM

As automobile manufacturers continue their current trend toward higher-compression engines, refiners face an ever increasing demand for premium motor fuels. New processes, or improvements on existing processes, are being installed to meet these demands. The fuel outlook is further complicated by the fact that the automotive industry is developing engines requiring lower grade fuels . . . and predictions indicate these engines will be in use by 1960.

THE SOLUTION

The fast growing petroleum industry is quick to recognize and adopt equipment which facilitates product movement . . . and continuous automatic blending gives refinery operation the flexibility it needs to keep pace with progress. Stream blending not only provides tailor-made hydrocarbons, but minimizes the need for intermediate tankage and allows specific seasonal market conditions to be met without costly inventory change-overs. B-I-F Industries, Inc. is the leading manufacturer of this type of equipment . . . and boasts the greatest number of diversified installations.

Features

- ★ *Complete stream blending systems, utilizing unitized construction, are available . . . factory-tested under field conditions.*
- ★ *All systems are electrically and mechanically interlocked to provide "fail-safe" operation under all job conditions.*
- ★ *Our "Blue Chip" products are designed, engineered, manufactured, assembled and tested . . . under one roof . . . assuring you of outstanding product quality and performance.*

"THE BEST COSTS LESS"

For engineered recommendations, write to **Proportioneers, Inc.**, Division of B-I-F Industries, Inc.

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Volume 35, No. 9 September, 1956

PETROLEUM REFINER
REFINING | PETROCHEMICALS | NATURAL GASOLINE

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A Quick Look

at This Issue

These handy digests permit checking ✔ those articles you want to read first.

PROCESS HANDBOOK

Process Handbook . . . This is the most complete tour through refining processes available today. You will want it for reference through the next two years until a new edition is published. In this section you will find 80 process descriptions with 80 flow diagrams. Each process is described in terms of its application, charge, products, operating conditions, yields, and commercial installations. The processes are divided into the following groups: Reforming, Cracking, Alkylation, Isomerization, Polymerization, Solvent Refining, Treating, and others. What's more, each of these types of processes is introduced by a quick summary that tells the common features and why they are important. It gives you a thorough understanding of refining processes today. Start this tour on **Page 197.**

☐ **What Hydrogen Treating Can Do . . .** Here is a comprehensive analysis of the ways in which hydrodesulfurization helps improve the quality of products from high sulfur crudes. It includes a detailed description of many of the processes which ushered this type of treating into prominence. Discussions of chemical and additive treating are included to complete the comparison, turn to **Page 306.**

☐ **Controlled Corrosion Cuts Costs . . .** Royal Dutch/Shell has avoided the use of expensive alloy steel when processing high sulfur crudes by applying the proper neutralization systems. For details on this successful operation, turn to **Page 319.**

☐ **How To Instrument a Heater . . .** Is it possible to use too many automatic controllers? Although fully automatic control of process heaters is rapidly gaining in use, it has certain disadvantages.

→ Now Turn the Page →

A Quick Look at This Issue . . .

Better results are often obtained by using manual control with automatic controllers set to the process requirements of the heater. For details on just when and where to use control instruments, turn to **Page 323.**

☐ **New Yugoslavian Refinery Uses Combination Approach . . .** This new refinery can meet gasoline quality by using a thermal combination unit. Reason: Gasoline market here is much lower in octane than U. S. levels. In this article, you'll find a complete description of the processing units and how they operate. **Page 330.**

☐ **What Price Hydrogen? . . .** Are you at sea as to the relative merits of various methods of producing and purifying hydrogen? If you are, here is a set of generalized graphs that may assist you in charting a course. Turn to **Page 333.**

☐ **Automation Today, Part 6 . . .** This is the last in the present series of articles on automatic control and control stability. The author summarizes the theoretical principles by applying them to a sample problem. To learn the general method of evaluating a control problem, turn to **Page 336.**

☐ **How to Select Centrifugal Pumps . . .** Which pump is actually cheaper? In selecting centrifugal pumps a slight mistake can often triple the cost. Use these tables and curves as a guide to the most economical selection for each pumping application. Turn to **Page 341.**

☐ **Phillips Gears Operations For Wide Diversification . . .** In the decade since World War II, diversification has been the key to a construction program which has lifted Phillips Petroleum Company from the class of a small independent refiner into the ranks of the majors. For the complete story, turn to **Page 194.**

☐ **Streamline Your Office Work . . .** A clerical work simplification program is eliminating waste of effort, time and money for Continental Oil Company. Turn to **Page 402** for a lesson in ". . . the organized application of common sense . . ."

☐ **Why Suggestion Systems? . . .** Suggestion systems are relatively new to the oil industry. In fact, only a short score of oil companies have an organized suggestion plan. Here is a candid appraisal of the reasons why the oil industry is lagging behind in making profitable use of employe ideas—plus many excellent arguments in favor of suggestion systems. Turn to **Page 410.**

☐ **Refining Behind the Iron Curtain . . .** Here is a PETROLEUM REFINER exclusive. For a complete country-by-country report on the refining industry in Russia and the European satellite nations—including number of refineries and crude charge capacity in each country—turn to **Page 417.**

☐ **World Demand to Increase One-Third in Five Years . . .** PETROLEUM REFINER researchers report on expected refinery expansion demands in next five years. For a complete analysis of world consumption of oil products in 1960, turn to **Page 426.**

☐ **Find the Reasons for Unsafe Acts . . .** Many refinery officials expect a set of safety standards to reduce accidents. This is not enough—the **reasons behind** accidents must be found before a safety program can succeed. For a timely discussion of ways to determine reasons behind unsafe acts, turn to **Page 428.**

The latest revised edition of the . . .

PETROCHEMICAL PROCESS HANDBOOK

• **64 process descriptions and diagrams** • **11 separation processes**
• **3 feature articles with lasting data**

A Complete Source of Petrochemical Processes

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PIPE LINE INDUSTRY and The PIPE LINE COMPOSITE CATALOG (first edition to be issued in July, 1957) for the oil and gas pipe line industry.

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Of Greatest Service

PETROLEUM REFINER readers, whether by mail survey or in our editorial conferences (we always invite three or four or five industry men to our planning sessions) invariably tell us that they "read the ads from cover to cover." In the advertising pages, these subscribers point out, are much engineering data of value in their work and a process man isn't going to stay well informed if he doesn't check the ad pages regularly. They are that important, industry men have assured us—time after time.

PETROLEUM REFINER advertisers make good use of their space. Month after month they present a mass of information that most certainly supplements editorial presentations. On these ad pages, it might be said, are to be found countless "tools of the trade" and, as many subscribers have testified, they could hardly stay up-to-date in their lines without such assistance.

As to the book which you hold in your hand: Within its covers is the greatest amount of advertising ever contained in an issue of PETROLEUM REFINER PLUS some 200 pages of editorial material the excellence of which is guaranteed by the very tag, "Process Handbook" (our 19th, incidentally). Here you have an issue that, based on past experience, stands to serve the processing industry to a greater degree than any single predecessor. And that's saying a lot. But as you thumb through its pages and check its content, see if you don't agree!

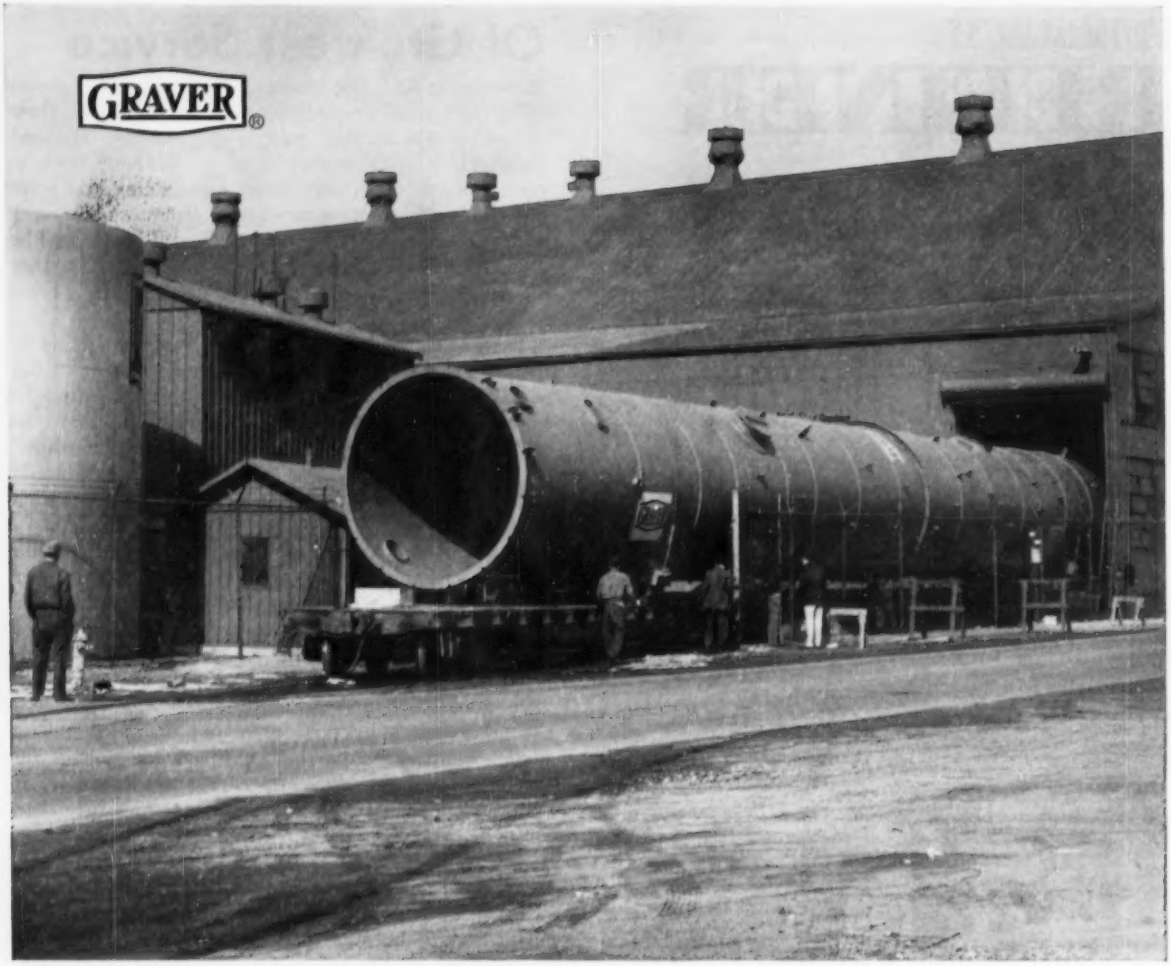
Most Useful Since '29

IT'S A PARTING of the ways after a long spell together, but the note that Theodore M. Hesser, former supervisor, Socony Mobil Oil Company, Pitman, N. J., wrote us recently made the goodbye a lot easier. Here 'tis: "I have been a PR subscriber since 1929 and have found it a most useful technical journal. However, having retired on July 1, I now have no further use for it. I do not plan complete inactivity but am preparing to enter the educational field as a high school science teacher. Best wishes for your continued success!"

And may we say, sir, best wishes to you, to. It's most commendable that teacher decision of yours and we'll bet you make a good one.

For the Asking—

SEVERAL SCHOOLS of journalism heads have commented favorably on our revised Author's Handbook. One even asked quotations on quantities and we promptly wrote him if he had in mind placing a copy in the hands of each engineering graduate, we'd rush him a supply. We figure those young fellows will be in industry before long and some of them will be writing for THE leading magazine in the refining-natural gasoline-petrochemical field. So it's natural we'd like them to know PR requirements and procedures. YOUR copy awaits a request from you. Address Editorial Director, PETROLEUM REFINER, Box 2608, Houston 1, Texas.



A Fractionator tower for the West

It's nosing out of the Graver plant at East Chicago—all 93 feet of it—on its circuitously routed journey to a western refinery.

Graver will design and build your complex process fabrications of carbon steel or alloy—stainless, stainless-clad, nickel-clad, Monel, Hastelloy or aluminum. Graver quality is assured by every modern technique for manual and automatic welding, stress relieving, heat treating, X-raying and other methods of inspection.

For the very best in custom-built process equipment and its installation, call on the experience of Graver.

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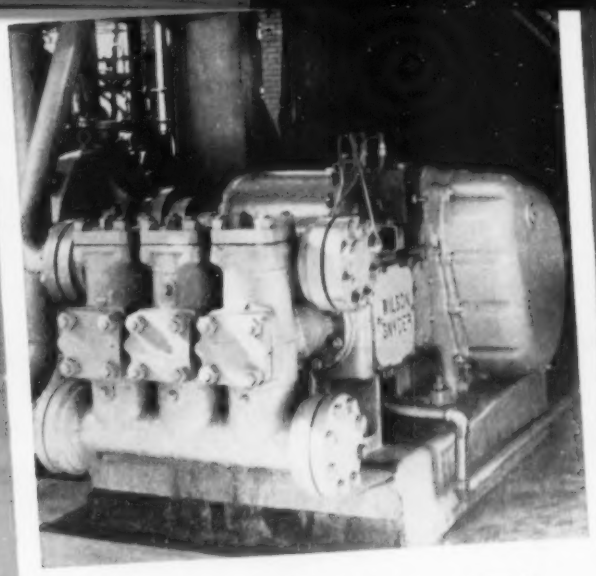
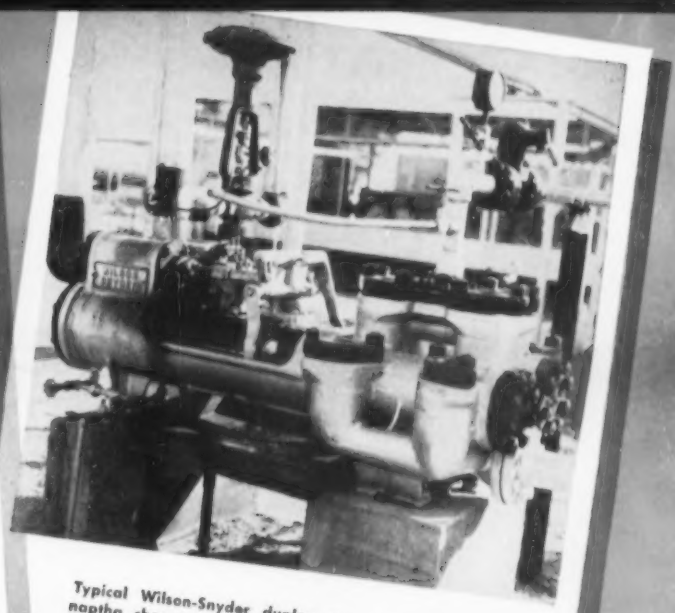


Typical Wilson-Snyder triplex plunger power pump in Universal Oil Products Platforming reactor charge service.



Typical Wilson-Snyder duplex steam pump handling naptha charge in an Atlantic Catforming installation.

Wilson-Snyder Reciprocating Pumps
—your best buy for LOW-Capacity, HIGH-Pressure Services

RECIPROCATING pumps offer many money-saving advantages over multistage centrifugals from 20 to 200 gpm when the differential head in feet is over 20 times the gpm.

LOW OPERATING EXPENSE—85 to 90% efficiency over the complete operating range is generally accepted for roller-bearing-equipped power pumps. The efficiency range of 20% to 60% for centrifugal pumps means that the user must have prime movers 425% to 42% larger than required for comparable reciprocating power pumps. *Think what this means in power savings!*

LOW MAINTENANCE EXPENSE — Reciprocating pumps develop high pressure at moderate speed and running clearance, whereas centrifugals depend on high speed at very close running clearances to develop pressure. Maintenance engineers know that grit, welding beads, mill scale, etc. in suction lines and vessels, as well as unstable suction conditions, can cause serious seizures and mechanical seal failures of multistage centrifugal pumps; with costly operating delays and expensive replacements. Why risk such failures to save a little floor space when dependability is your most important need?

EXPERIENCE—For over 75 years, Wilson-Snyder has furnished heavy-duty pumps of the highest quality, and performance records in thousands of refinery installations throughout the United States and foreign countries have established them as the industry's finest pumps. As a builder of both centrifugal and reciprocating types (including power and direct-acting steam) you can be sure of an unbiased recommendation as to which type will best suit your conditions.

Give your nearest "Oilwell" Pump Specialist an opportunity to quote on Wilson-Snyder pumps for your requirements.

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UNITED STATES STEEL

another complete refinery

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The photograph, shows the following process units, from left to right: 41,600 bbl/day two-stage Crude Distillation unit; 13,000 bbl/day Model IV Fluid Cat Cracking unit; Light Ends Plant; 4,000 bbl/day Catalytic Polymerization unit.

Also included will be a 7,000 bbl/day Powerformer with integral Hydrofiner for feed preparation and a 500 bbl/day LPG unit, scheduled for completion before the end of the year.

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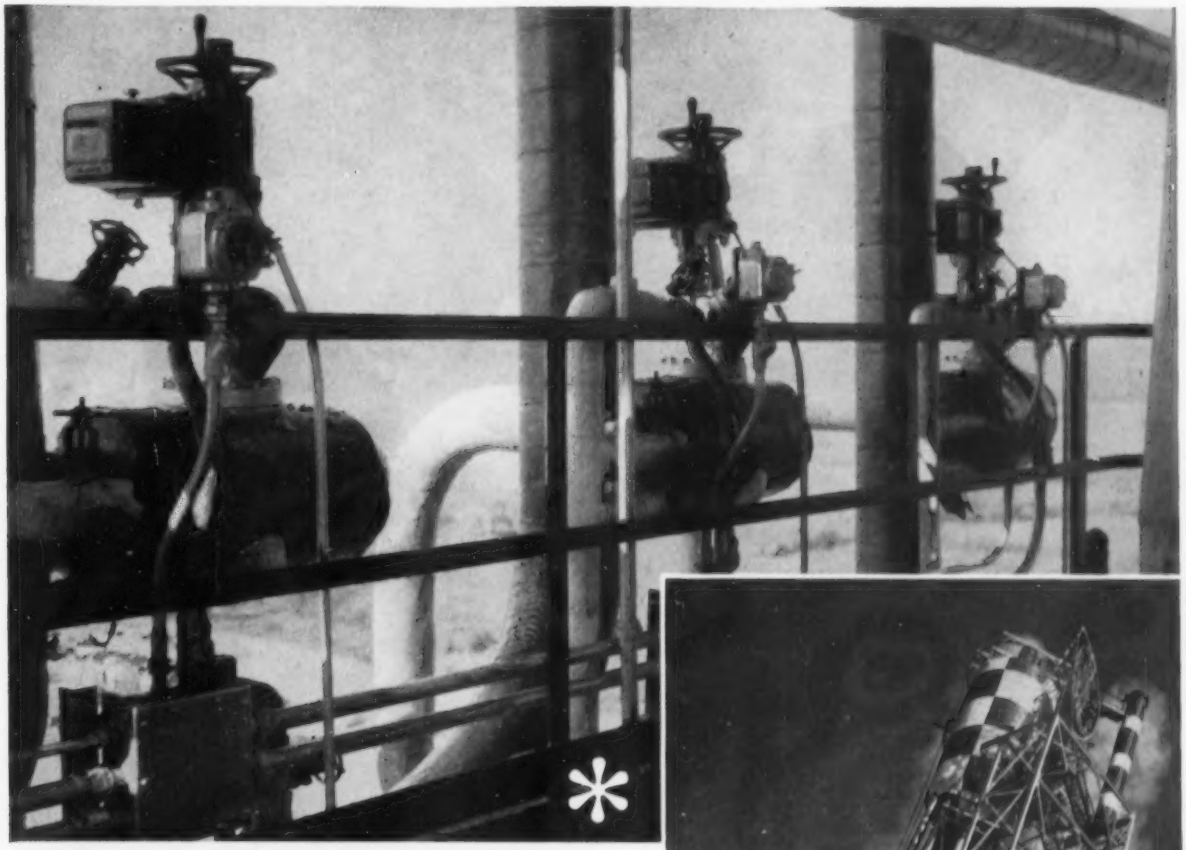
Push-Button Control *FOR* PETROFINA'S NEW 16,000 BPD PLANT



...where dependability counts—the choice is

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LimiTorque valve controls provide truly *automatic* operation for catalyst return pipe valves on Canadian Petrofina's newest Houdriflow Catalytic Cracker. This giant unit provides the major portion of high-octane gasolines at the Montreal refinery.

LimiTorque operates at the mere "push of a button," saving time, labor, and money as compared to expensive, time consuming manual operation of valves at distant or inaccessible locations. LimiTorque opens and closes valves at the exact speed required. It also "limits the torque" applied to valve operating parts, preventing possible damage to valve stems, seats and discs.

LimiTorque may be actuated by any available power source, including Electricity, Oil, Gas, Water or Air, and is now available for Microwave control.

For the full story on LimiTorque, please request Catalog L-550.

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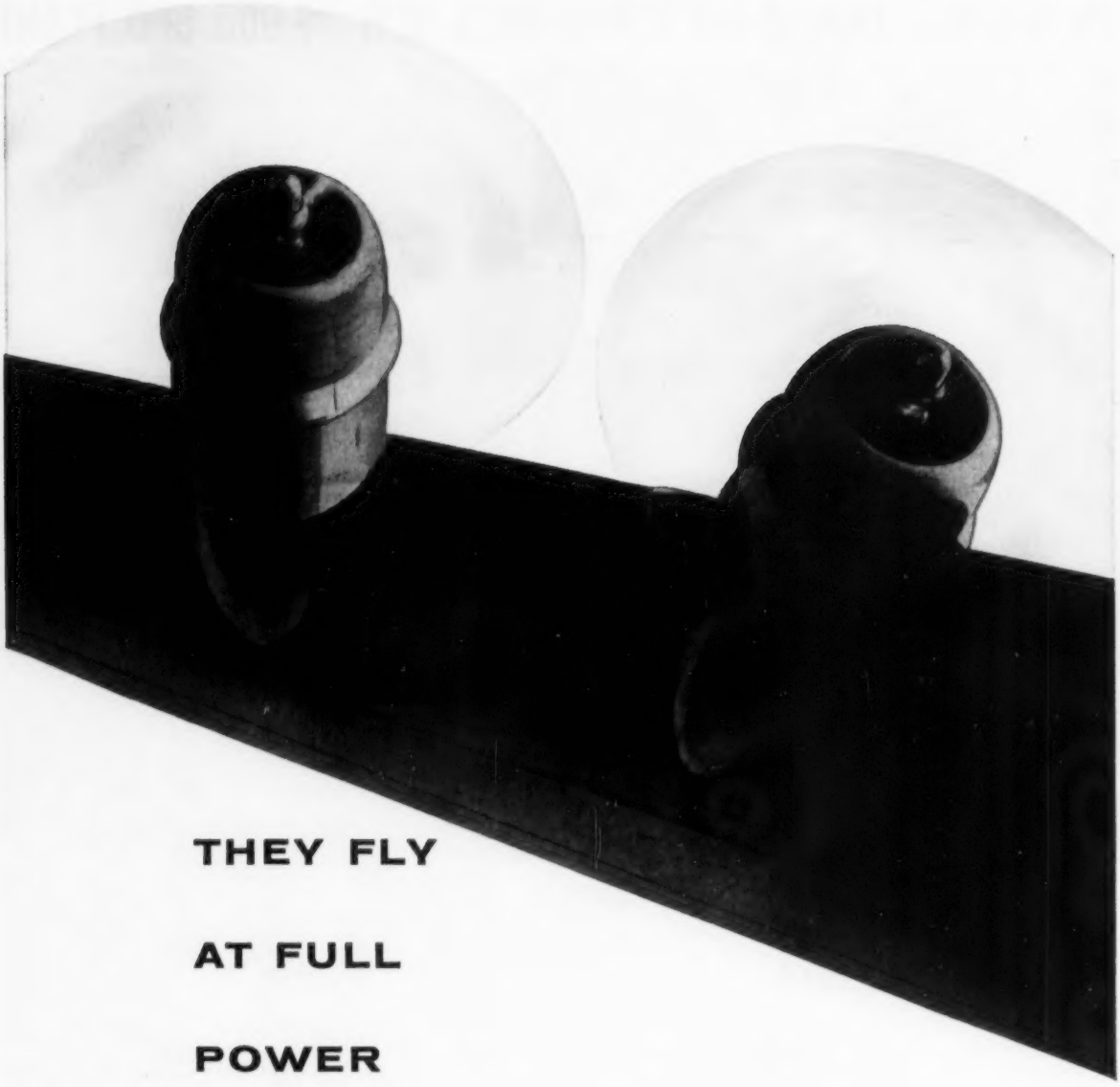

THEY FLY AT FULL POWER WHEN GASOLINE CONTAINS

Tenamene

EASTMAN GASOLINE ADDITIVES

Protect the performance of the gasolines you produce. Tenamene inhibits gum formation, assuring engines of the full power you build into your fuels. An Eastman petroleum specialist is always available to assist you in achieving maximum performance from these dependable additives.

For more information on Tenamene additives and the service that backs up their proper use, contact our local representative or write to EASTMAN CHEMICAL PRODUCTS, INC., *subsidiary of Eastman Kodak Company,* KINGSPORT, TENNESSEE.

SALES OFFICES: Eastman Chemical Products, Inc., Kingsport, Tennessee; New York City; Framingham, Mass.; Cincinnati; Cleveland; Chicago; St. Louis; Houston. **West Coast: Wilson Meyer Co.,** San Francisco; Los Angeles; Portland; Salt Lake City; Seattle.

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Operating plants are today proving the worth of Catalytic's ability to design for profit.

Pioneering achievements in such diversified fields as metallurgy, petroleum, chemicals, and petrochemicals are recorded in concrete and steel.

The skill, creative ability, and experience of Catalytic's personnel, alone or supplementing the engineering forces of your own organization, can create the kind of plant that will produce profits for you.

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CATALYTIC *ON-TIME... ON-BUDGET* SERVICES
for the metallurgical, chemical, petrochemical and oil refining industries: Project Analysis; Process Development; Process Design; Economic Studies; Engineering; Procurement; Construction; Plant Operation

For more data on advertised products, use Readers' Service Cards, last page.

DUAL METAL··· answer to

What is it ?

To thirty-one of America's largest industries with problems of abrasion or corrosion — or both —"Dual Metal" means U. S. Pipe's Steel and Tubes Division.

Specifically, "Dual Metal" is our name for centrifugally cast cylindrical sections in which two dissimilar metals are bonded metallurgically by centrifugal force and temperature.

"Dual Metal" centrifugally cast, integrally fused combinations of two dissimilar metals are doing industry's most difficult and exacting jobs better and more economically than ever before.

Design engineers have been quick to recognize the outstanding merits of a process capable of combining the desired mechanical and chemical properties no single metal possesses.

"Dual Metal" means versatility, efficiency and economy.

Research and development play a vital and important role in the centrifugal casting of "Dual Metal" combinations. Our Pilot Foundry is devoted entirely to process and product improvement.

UNITED STATES PIPE & FOUNDRY CO.

Steel and Tubes Division

STEEL AND TUBES DIVISION U S P

BURLINGTON, NEW JERSEY

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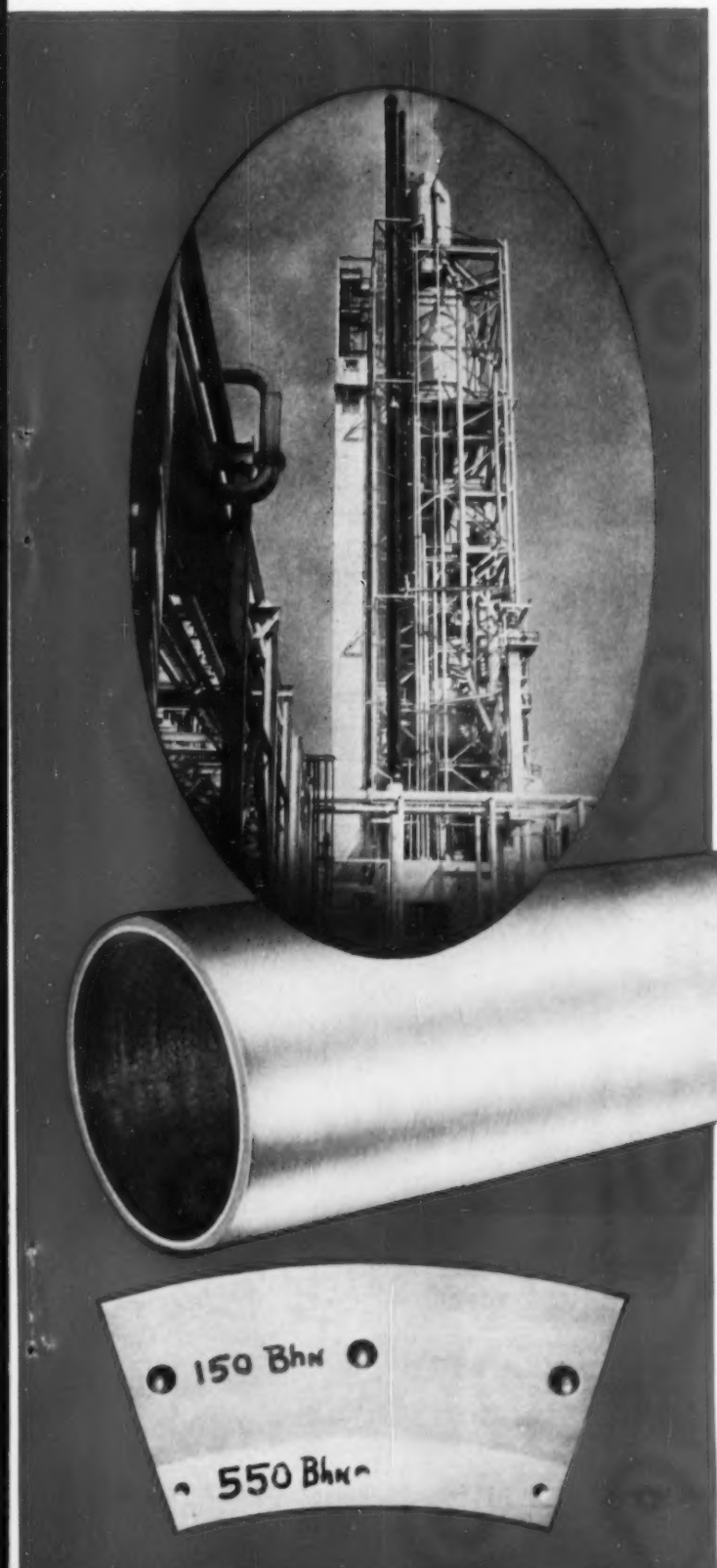
your TURNAROUND problems



"Dual Metal" solves one of the petroleum industry's most severe and costly problems — catalyst erosion of lift pipe and catalyst handling lines.

In making a "Dual Metal" lift pipe the outer shell of weldable alloy steel is poured into a rapidly rotating mold. The abrasion-resistant alloy iron core is introduced at the proper time and temperature. Result? A metallurgically bonded two-metal structure that combines the strength and weldability of low alloy steel and the superior abrasion resistance of alloy iron.

"Dual Metal" lift pipes are now in use in over 80 of the nation's leading refineries. In one typical refinery periodic examinations of high temperature catalyst pipes have indicated abrasion resistance of better than 16 to 1 over conventional steel piping. A once-troublesome bottleneck in processing has been eliminated and turnaround operations made shorter — a major saving of both time and money.

Perhaps this versatile process is the answer to your particular problem. Write today for specific literature and information on "Dual Metal's" applications for the refining industry.

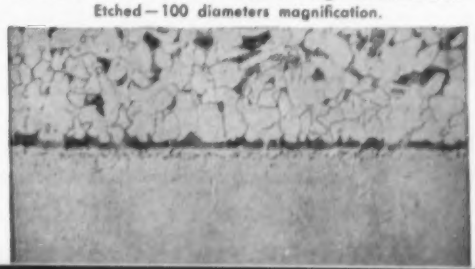
"DUAL METAL" CENTRIFUGAL CASTINGS: SIZE RANGES

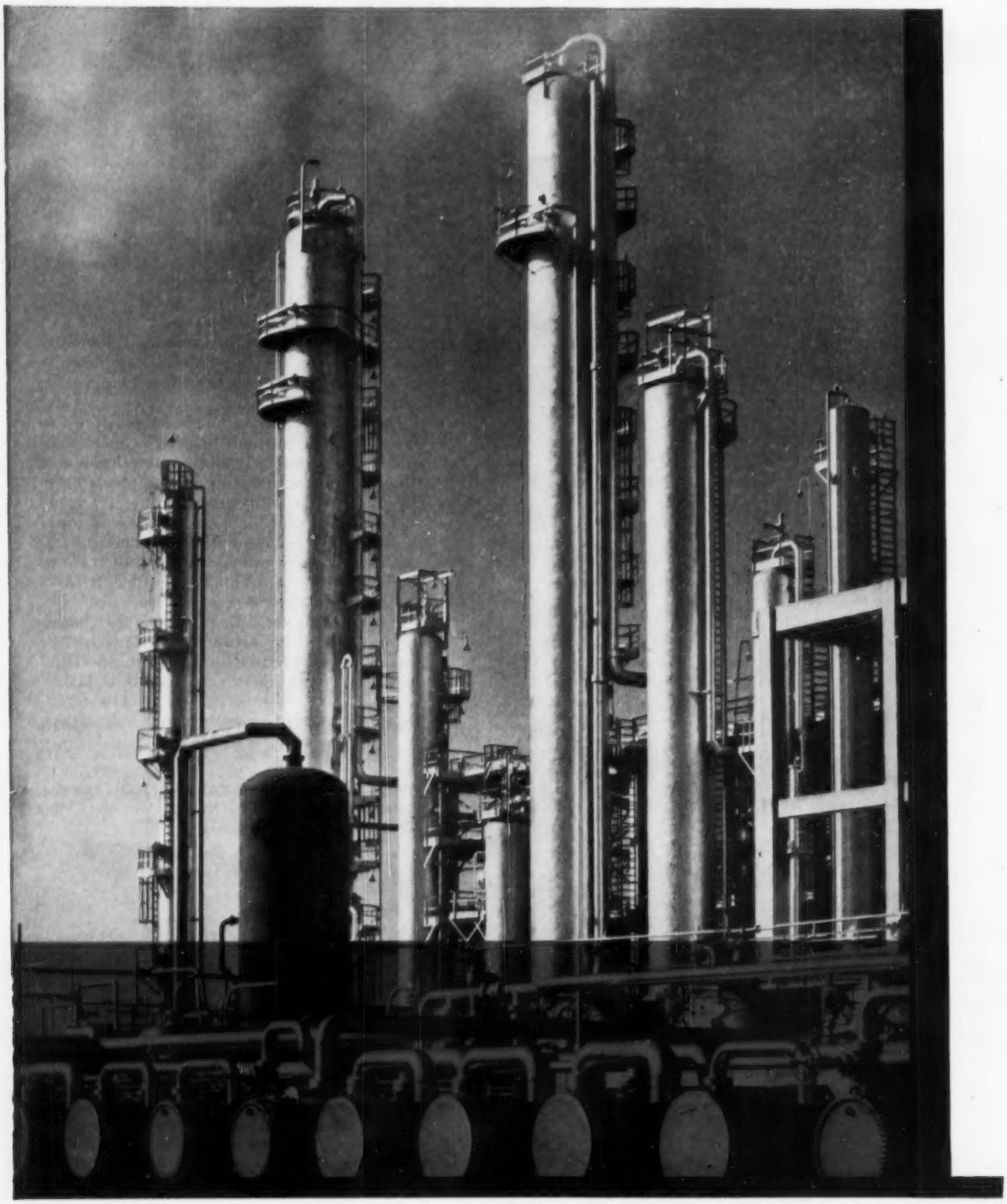
OUTSIDE DIAMETER: 6" to 50" WALL THICKNESS: ½" and up
LENGTH: Up to 16 ft.
TYPICAL OIL INDUSTRY APPLICATIONS: Catalyst Lift Pipe, Depressurizing Pipe, Catalyst Transfer Lines, Slush Pump Liners, Valve Nozzles, Extrusion Liners, etc.

Left. Cross-section view of dual metal piping consisting of a weldable SAE 4120 steel outer shell and a metallurgically bonded inner layer of high carbon-high chromium abrasion resisting iron. Photograph actual size. Composition of the hard inner layer:

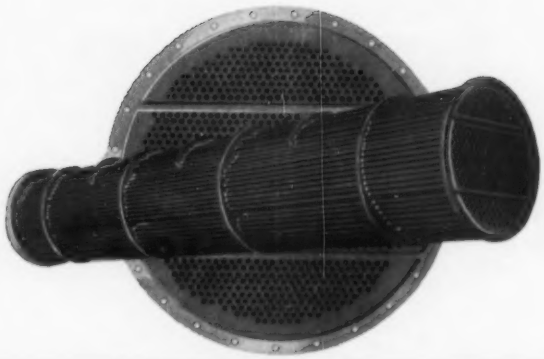
C	Mn	P	S	Si	Cr
2.85	1.10	.009	.023	.85	29.36

Below. Photomicrograph showing the bond or fusion zone between the outer and inner metals. The mild etch required for the 4120 steel did not attack the high chromium iron. Etched — 100 diameters magnification.





FIRST FOR LASTING QUALITY—FROM MINE TO MARKET!



For dependable "on-stream" performance . . .
retube your exchangers with

PHELPS DODGE HEAT EXCHANGER TUBES!

Wide selection of copper-base alloys for every type of application—including bi-metal combinations.

Complete warehouse stocks maintained at Houston, Texas; Tulsa, Okla.; Los Angeles, Cal.; Chicago, Ill.; and Bayway, N. J.

Expert assistance in solving your tube corrosion problems.

Specify Phelps Dodge . . . One of the largest suppliers of tubes to manufacturers of heat exchangers!

PHELPS DODGE COPPER PRODUCTS CORPORATION

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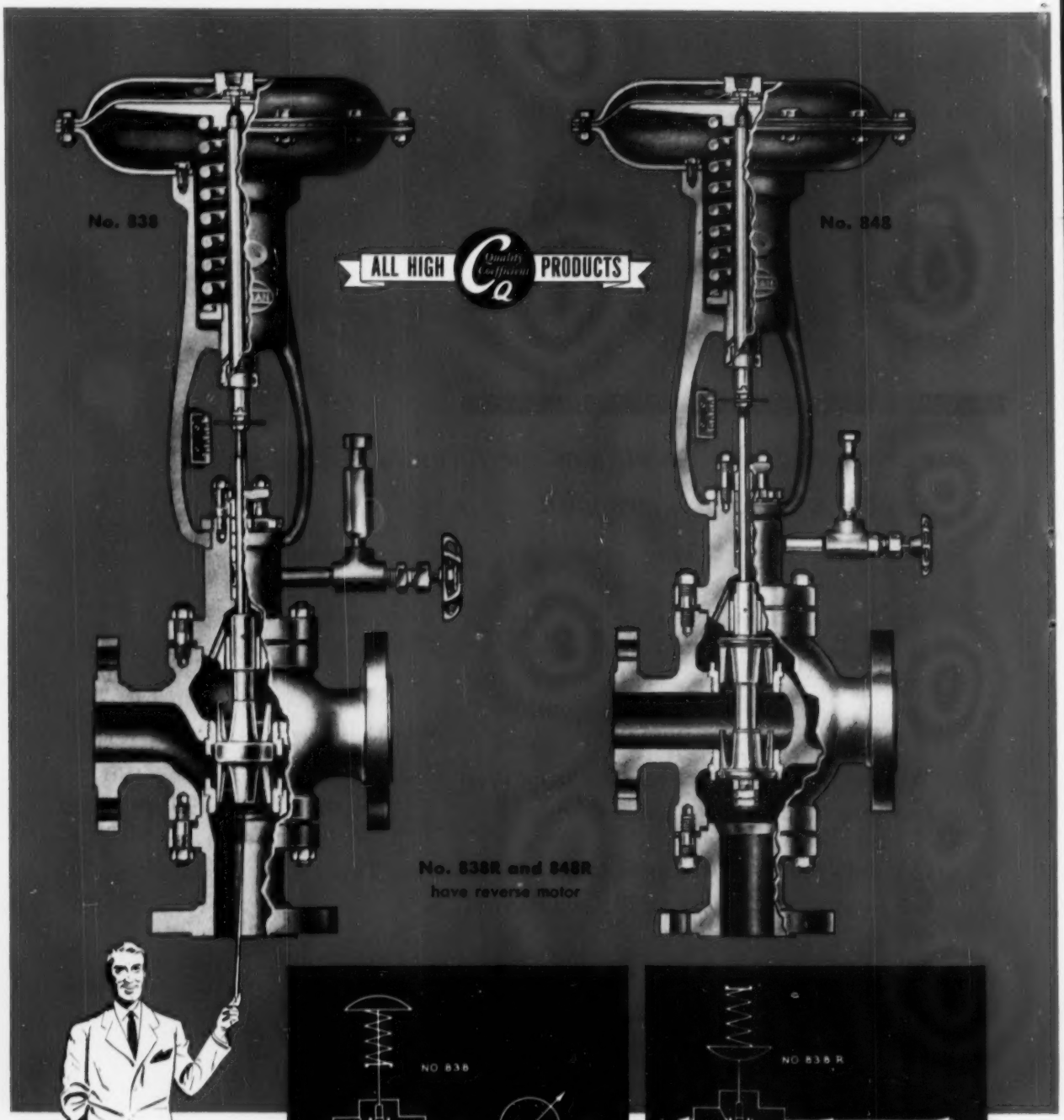
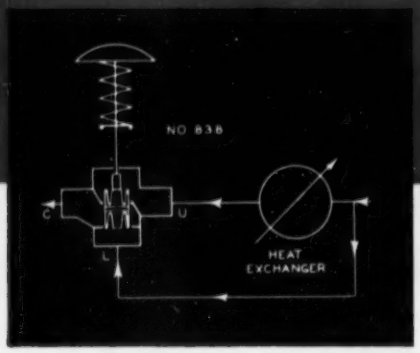
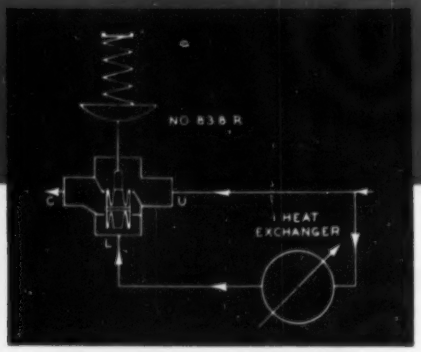






Combining Service

In these typical applications of Masoneilan 3-way valves, No. 838 and 838R (above) are installed downstream of a heat exchanger for combining service; and No. 848 and 848R (shown on next page) are installed upstream for diverting service. In combining, the heating medium is brought in through ports U and L and out through common port C. In diverting, the fluid is brought in through port C and out through ports U and L.

For more data on advertised products, use Readers' Service Cards, last page.

Select Masoneilan 3-Way Control Valves to get...

Stability and Flexibility In Combining or Diverting Service

Choice of seating arrangement permits installation to obtain the inherent stability (and maximum allowable pressure drop) of flow tending to open both ports. No. 838 and 838R use a single seated body and a plug with seats back to back *inside* the seat rings. No. 848 and 848R use a modified double seated body and a plug with seats face to face *outside* the seat rings. Plugs are *top* and skirt guided for more accurate alignment and long service life.

Choice of motors permits obtaining maximum operating force, with same available thrust at both ends of the stroke or with a high thrust in one direction if desirable. 3-15 or 6-30 psi spring ranges and availability of oversize diaphragm cases allow a wide selection of motors, either direct or reverse. Enables you to choose, also, the action providing greatest safety factor in the event of air failure.

A more detailed discussion of these valves is available. Write our office nearest you, or

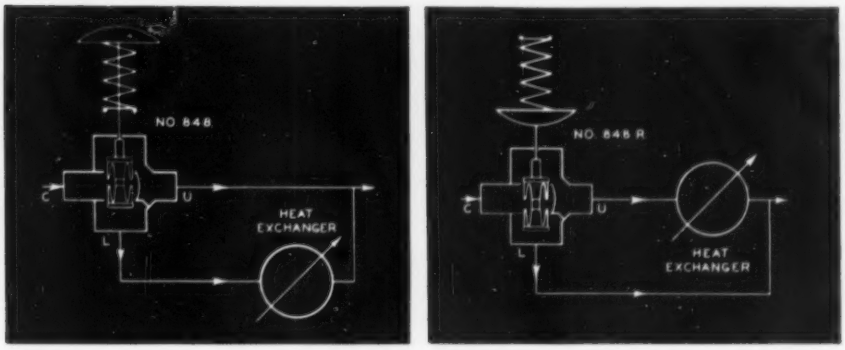
MASON-NEILAN

MASONEILAN

Division of Worthington Corporation

51 NAHATAN STREET, NORWOOD, MASSACHUSETTS

Sales Offices or Distributors in the Following Cities: New York • Syracuse • Chicago • St. Louis • Tulsa Philadelphia • Houston • Pittsburgh • Atlanta • Cleveland • Cincinnati • Kansas City • Phoenix Detroit • San Francisco • Louisville • Salt Lake City • El Paso • Albuquerque • Charlotte Los Angeles • Corpus Christi • Denver • Appleton • Birmingham • New Orleans • Seattle Mason-Neilan Regulator Co., Ltd., Montreal and Toronto



Diverting Service

Since maximum unbalance occurs across the bypass port, motor action is normally selected so that an increase in diaphragm pressure will tend to close the bypass port. The flow direction shown in all these diagrams tends to open both ports and maximum motor operating force is available to overcome off-balance. The valves are arranged so that the heating medium to the exchanger will be shut off in the event of air failure.

For more data on advertised products, use Readers' Service Cards, last page.

Buyers of Any Process Equipment Reap Benefits from M. W. Kellogg's

COMMITTEE WORK

ANOTHER PLUS IN KELLOGG'S
BUILT-IN ENGINEER

As a leader in the design and fabrication of petroleum and petrochemical process equipment, The M. W. Kellogg Company assumes many extra curricular responsibilities which eventually benefit not only its customers but the process industries in general. One of these responsibilities is Kellogg's participation in technical committees of professional societies and associations, particularly at subcommittee working levels.

At present, M. W. Kellogg's engineers, metallurgists and others give a considerable part of their time to over seventy such activities . . . ranging from boiler and pressure piping codes to welding practices and radiographic testing techniques. Many of today's accepted design concepts were introduced to the engineering profession by Kellogg committee men.

The M. W. Kellogg Company is privileged to contribute increasingly to the important work of technical and engineering societies, associations, and related groups. The practical application of the knowledge imparted and gained is another plus which goes into Kellogg's "built-in engineer" approach to process equipment design and fabrication. A typical example is a paper prepared by M. W. Kellogg engineers, "Collection and Correlation of High Temperature Hydrogen Sulfide Corrosion Data," and presented at a recent meeting of the National Association of Corrosion Engineers. *Write for your copy.*

Fabricated Products Division

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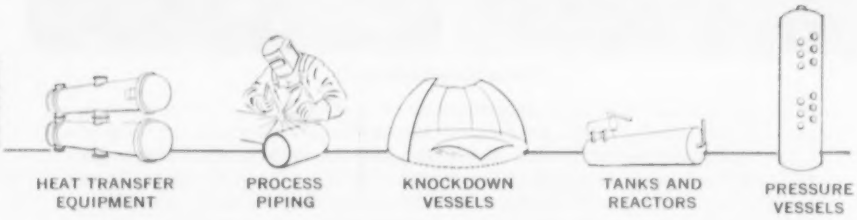
KELLOGG



Alcoa Products *for the Chemical and Petroleum Industries*

ALUMINUM *for*

Process Equipment • Transfer and Storage • Plant Structures

CHEMICALS:

ALUMINAS for Catalysts • Bed Supports • Desiccants • Refractories

GALLIUM--FLUORIDES

ALUMINUM COMPANY OF AMERICA

Aluminum in Process Equipment

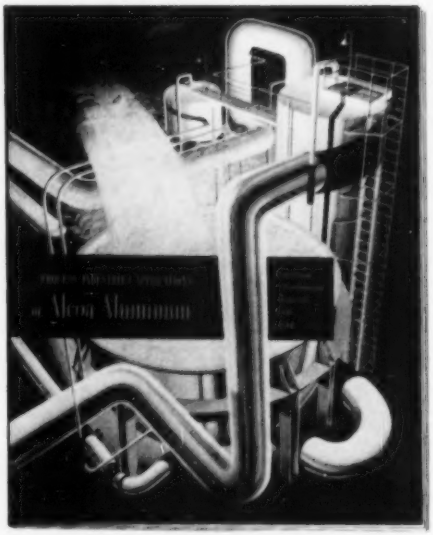
Aluminum is widely used in many types of processing equipment because of its unique combination of desirable properties:

- Excellent resistance to corrosion
- Light weight
- Good workability
- Low cost
- High thermal and electrical conductivity
- Great strength in alloys
- Nonmagnetic and nonsparking characteristics
- Nontoxicity
- Good reflectivity
- Clean, attractive appearance

No other metal combines all these properties, so no other metal can be used with comparable results in so many different process applications. And even in those applications where other metals could be substituted, the cost of Alcoa aluminum often is substantially less.

In the processing of foods and beverages, the refining of petroleum, the production of basic chemicals and pharmaceuticals, the manufacture of paper and plastics, and in many other processes, aluminum is doing hundreds of jobs and doing them well.

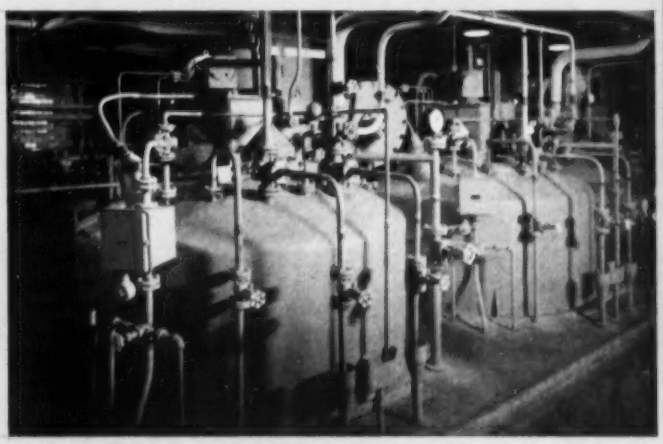
Some of the principal applications of aluminum in the process industries are described briefly here. More detailed information on the behavior of aluminum with specific materials, as well as design and performance data are contained in the book, *Process Industries Applications of Alcoa Aluminum*. Your copy will be sent promptly on request.



Process Vessels

Aluminum can be readily fabricated by conventional methods into heat exchangers, kettles, storage tanks, stills, driers, pasteurizers, towers and other process vessels. Because it resists attack by many materials often regarded as corrosive, aluminum can be used in a wide variety of operations. Excellent heat conductivity makes it especially useful in vessels where heat must be applied to the product. Because aluminum can be *kept* clean and *looks* clean, it is particularly appropriate for use in food processing plants.

Aluminum vessels impart no undesirable color or flavor to the products. They can be used for fermentation reactions in brewing and in microbiological production because aluminum is nontoxic to the micro-organisms.



3,000-gallon aluminum adsorption tanks are used in the production of Chloromycetin and streptomycin.

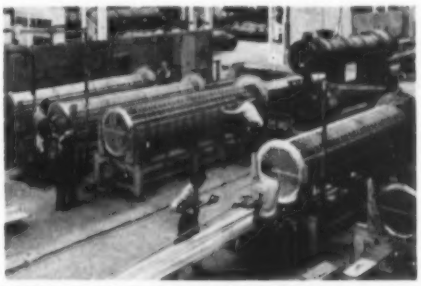
Heat Exchanger Tubes

The qualities which make aluminum well suited for use in heat exchanger tubes are low cost, resistance to oxidation and other chemical attack, ease in fabrication, and excellent thermal conductivity.

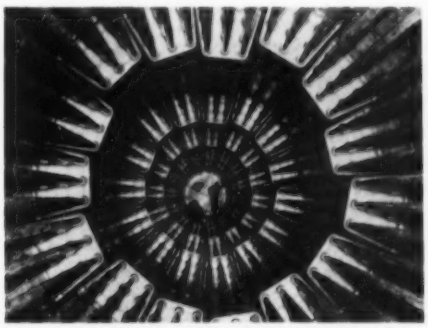
Corrosion problems often are accentuated at elevated temperatures. Aluminum tubes have demonstrated their ability to give long, dependable service under severe conditions. They are used extensively in exchangers for handling hydrogen peroxide, nitric acid, hydrogen sulfide, ammonia, soda ash, naval stores, glycerine, acrylonitrile and other chemicals. Alclad tubes are particularly used to resist premature perforation from natural cooling waters.

Aluminum costs less initially than other materials—½ less than admiralty, less than ⅓ the cost of stainless, and in the common ¾" and 1" sizes, less than mild steel.

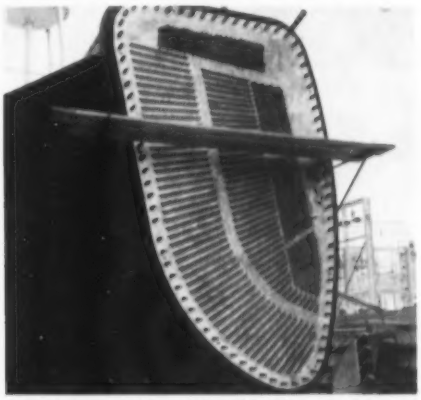
Detailed information on Alcoa aluminum for heat exchanger tubes is contained in booklet AD186, available on request.



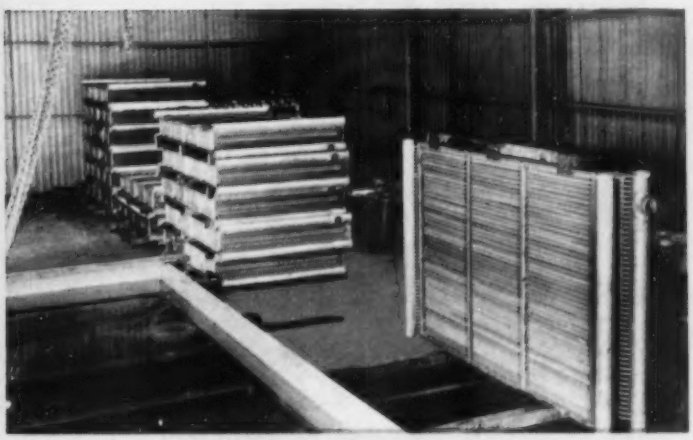
Fabrication of a group of all-aluminum heat exchanger bundles for the petroleum industry.



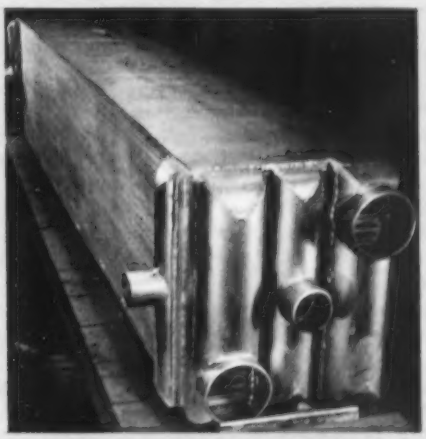
Interior view of the world's largest rotary steam tube dryer, made of aluminum to protect product color.



View during installation of a 35,000 sq ft aluminum-tubed surface condenser in a steam power plant.



All-aluminum, water-cooled, finned-tube heat exchanger for conditioning air used in a large wind tunnel.



This brazed aluminum assembly, weighing nearly 900 pounds, provides heat interchange between five substances simultaneously.

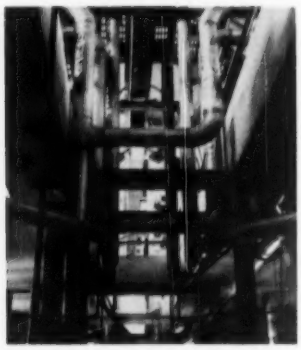
Transfer and Storage

Process Piping

Alcoa aluminum pipe is used to carry liquids and gases in chemical, petrochemical, petroleum, and food processing plants. Aluminum pipe resists attack by the materials carried as well as by the corrosive atmosphere often encountered around such plants. The product is also protected from contamination or discoloration.

For most process applications, schedule 40 pipe is recommended. Aluminum pipe is available in all of the normally produced schedules.

Where resistance to corrosion or protection of product is an important consideration, Alcoa Aluminum piping is often the least expensive material that will do the job satisfactorily.



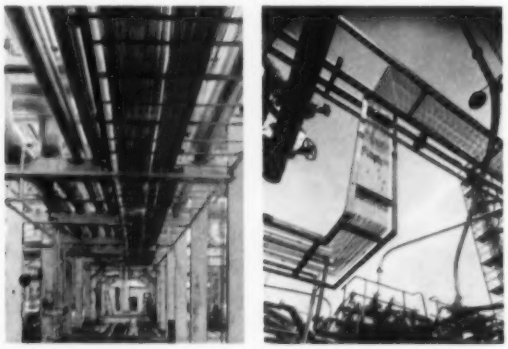
Alcoa Aluminum pipe is made in several weights and in a range of sizes in accordance with ASA Schedule Nos.

Utilitube*

Alcoa Utilitube is aluminum coiled tube made of a specially selected alloy which combines low cost, easy workability and high fatigue strength. It is used effectively in instrument air lines, hydraulic and lubricating lines, and refrigeration tubing.

Alcoa Utilitube has the excellent corrosion resistance typical of aluminum, along with high bursting strength and good mechanical properties. It is supplied in economical lengths of 1,000 feet or longer.

Alcoa Utilitube weighs only ⅓ as much as copper tubing of similar capacity and costs up to 40% less.



Alcoa Utilitube is used as instrument air lines in many chemical and petroleum plants. Costing up to 40% less than copper tube, Utilitube is available in 1000 foot lengths in certain sizes. Fittings for Utilitube are available from several suppliers.

Unitrace*

Alcoa Unitrace is a steam-traced pipe which eliminates the expense of external jackets or steam traced tubes by making the steam line an integral part of the aluminum pipe. Users report savings of up to 30% in labor cost, plus important reductions in material and insulation costs.

Unitrace provides greatly improved heat transfer properties. Pre-formed insulation will fit Unitrace although its improved efficiency makes thermal insulation unnecessary in many cases.

Unitrace can be formed easily with conventional pipe-bending tools. The standard lengths are well adapted to shop fabrication.

More detailed information on applications and methods of using Unitrace are contained in bulletin AD418.

*Registered trademarks

Fittings and Valves

Where aluminum pipe or tubing is used, it is desirable to complete the system with aluminum fittings and valves.

Alcoa does not manufacture valves, but it does supply aluminum to other manufacturers who do. Your Alcoa representative can furnish the names of competent suppliers.

Unitrace section showing trace line cut back for joint.

Special cast Unitrace flange for simple, efficient joining of Unitrace sections.

Standard and Special Storage Tanks

Alcoa standard storage tanks, fabricated of 3003 alloy, are supplied in a number of sizes ranging from 580 to 21,400 gallons. They are available in both horizontal and vertical construction.

Made from stocked components, these standard tanks bring the user all the advantages of Alcoa Aluminum at lower cost and with faster delivery.

Special storage tanks to meet any requirements may be constructed of Alcoa sheet and plate. Information on design and fabrication will be furnished on request.

World's largest all-aluminum tank stands 26 feet high, has a diameter of 128 feet, holds 2⅓ million gallons of 83% ammonium nitrate solution.

Alcoa Standard Tanks provide economical storage for a wide variety of chemicals.

Shipping Containers

Alcoa offers a wide variety of shipping containers conforming to ICC regulations. These containers range in size from 7½ to 110 gallons and are used for shipping such diverse products as beer and fuming nitric acid.

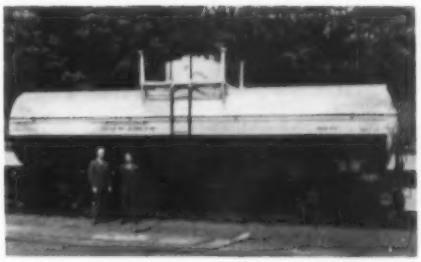
Alcoa aluminum containers are lighter in weight than containers of other suitable materials, are less expensive and give longer service.

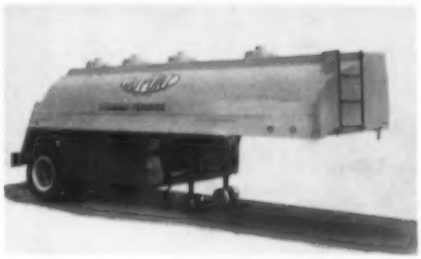
Tank Cars, Trucks, and Trailers

The use of Alcoa aluminum in tank cars and trucks provides important advantages in ultimate cost and flexibility.

Aluminum tank cars and trucks are used extensively for transporting ammonium nitrate, acetic acid, nitric acid, acrylonitrile, hydrogen peroxide, formaldehyde, glycerine, alcohols, and other chemicals, as well as petroleum products, dairy products, edible oils and rosins. For more detailed information on the behavior of aluminum with various products, refer to *Process Industries Applications of Alcoa Aluminum.*

The light weight of aluminum makes possible a higher ratio of payload-to-gross weight in highway trucks and trailers. The fact that aluminum is resistant to so many kinds of corrosive attack keeps maintenance to a minimum.



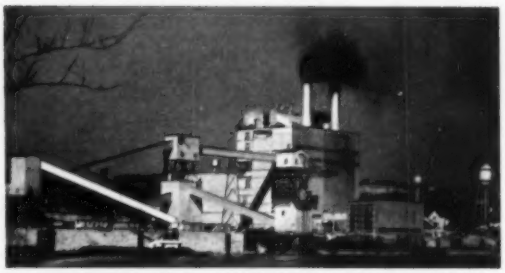


Plant Structures

Roofing, Siding, Structurals

Alcoa industrial building sheet is used for roofing and siding on plant buildings and to protect conveyors and other outdoor equipment. The aluminum surface requires practically no maintenance and lasts well even when exposed to corrosive atmospheres often encountered around processing areas. It is easily installed and helps to keep construction costs low.

Alcoa also supplies structural shapes for use in construction where their corrosion resistance and consequent low maintenance cost are advantageous.



Aluminum exterior surfaces for buildings and conveyors provide pleasing appearance with minimum maintenance.

Aluminum Paint

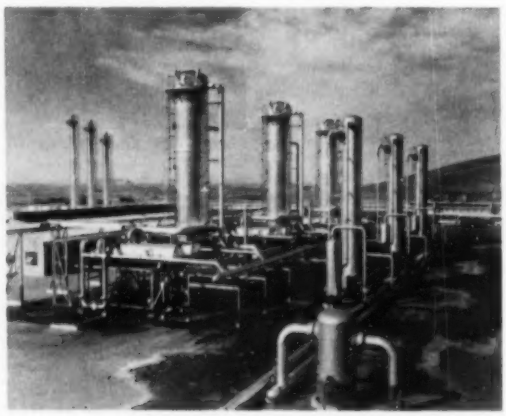
Alcoa manufactures high quality aluminum pigments which are used by leading paint manufacturers in aluminum paints. Aluminum pigment differs from ordinary paint pigments in that the particles are leaf-like rather than granular. As the paint is applied, these flakes of pigment arrange themselves in parallel layers, forming a continuous metallic sheet of pure aluminum, which provides unmatched protective power.

Aluminum paints are available in various types to meet all plant needs. Included are special silicone-base formulations for use on heated metal surfaces. These silicone-aluminum paints will not break down on surfaces that get as hot as 1000°F.

Towers, piping and other equipment in this petroleum processing plant are protected by aluminum paint.

Weatherproofing for Thermal Insulation

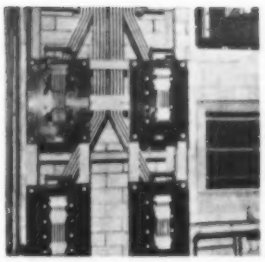
Aluminum sheet or foil jackets are frequently used to weatherproof thermal insulation. Such coverings protect the insulation from weather and wear, and, in special designs, may serve also as vapor barriers.



Aluminum sheathing weatherproofs thermal installation on towers, heat exchangers and piping at this natural gas treating plant.

Bus Bars

The excellent electrical conductivity of aluminum is employed advantageously in bus bars for use in process plants. Low cost per unit current capacity and good corrosion resistance are key advantages.



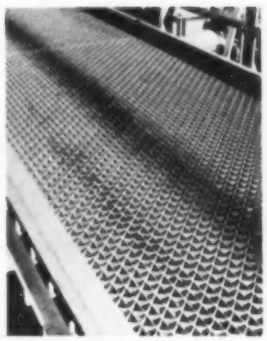
Rigid Conduit

Alcoa rigid conduit is light in weight and easily formed, simplifying installation. Its smooth inside surface makes for easy "fishing," and the well-known corrosion resistance of aluminum guarantees long life for the installation.

Grating and Tread Plate

Aluminum grating is used widely for floors and walkways in and around processing plants because of its light weight, resistance to corrosion and low maintenance requirements. Its nonsparking characteristic is an important safety feature in petroleum refineries, on tankers, and wherever explosion hazards are found. Check with your Alcoa sales office for names of suppliers.

Alcoa supplies both a standard aluminum tread plate and Alcoa abrasive tread plate. The latter has a bonded abrasive surface for extra nonskid protection.



Handrails

Stairs, walkways, platforms, and similar places require dependable protection for personnel. Handrails of Alcoa aluminum are light, strong, and dependable, and will remain safe and attractive with practically no maintenance.

Aluminum piping or extrusions can easily be fabricated into practical rails.

Chain Link Fence

Chain link fence made of Alcoa aluminum wire is extremely weather resistant and does not require painting even in saltwater exposure. Aluminum fencing is especially suitable for use around processing plants because it will provide long service with practically no maintenance.

Windows

Dimensional stability, resistance to weathering, ease of installation and operation, and attractive appearance are the principal advantages of aluminum windows.

Window frames are available in a wide range of standard sizes, and special sizes can be readily fabricated of aluminum extruded stock. Consult the nearest Alcoa sales office for names of suppliers.

Hoods and Ducts

Aluminum sheet is easy to fabricate by conventional sheet metal methods. This, along with its other desirable properties, particularly resistance to corrosion, suggests its extensive use for a wide variety of duct work in processing plants.

Fasteners

Alcoa supplies a complete line of rivets, nuts, bolts, washers, machine screws, sheet metal screws, and certain types of nails in most standard sizes and lengths.

The use of aluminum fasteners with other aluminum components is in accord with best engineering practices. The absence of corrosion assures cleaner, stronger, longer-lasting joints.

ALCOA Aluminas . . to improve processing

Throughout the process industries, versatile Alcoa® Aluminas are widely used to up-grade chemical reactions, speed processing and create better products at lower cost. Their high chemical purity combined with important thermal and physical characteristics makes them ideally suited to a broad range of applications in a variety of processes. There is a type and grade of Alcoa Alumina perfectly matched to specific process requirements in such diverse uses as these:

Catalysts and Catalyst Supports

Alcoa Activated, Tabular and Calcined Aluminas improve catalytic reactions in several ways. They permit close control of reaction rates. They substantially reduce carbon deposits. And they frequently lower operating temperatures. This results in increased catalytic process yields with substantial reduction of losses from contamination and side reactions . . . good reasons why it always pays to insist on ALCOA Aluminas for catalysts and catalyst supports.

Bed Supports and Covers

Alcoa Tabular Alumina Balls offer a perfect answer to the need for stable, noncontaminating bed supports and covers for catalysts and desiccants. Neutral, nonreactive and highly refractory, they keep catalyst contamination negligible . . . an important *plus* when they are used in reactors employing expensive catalysts. Alcoa Tabular Alumina Balls are available in several grades to fit varying thermal and mechanical requirements, and in sizes ranging from ¼" to ¾". Whatever the reaction process, they afford economy, adaptability and peak operation of reactor towers.

Drying Agents

Alcoa Activated Aluminas are synonymous with fast, efficient dehydration of liquids, gases and vapors. The oldest, most thoroughly proved commercial desiccants, they dry to lower dew points (minus 100°F and lower) than any other. They are uniform in purity, composition and structure. They are nontoxic and inert to most gases and vapors. Their particles are strong and do not break down through repeated cycles of saturation and reactivation. Their relatively low cost and ability to stand up through almost endless reactivations make Alcoa Activated Aluminas the most economical solution to the problem of fast, efficient, *dependable* dehydration.

Refractories

Alcoa Aluminas used to fortify refractories enable them to withstand higher process temperatures longer. In fact, refractory performance increases in almost direct proportion to the amount of Alcoa Alumina used. These are the outstanding characteristics afforded by high alumina refractories: exceptional strength and stability under load at high temperatures . . . extremely high resistance to thermal and mechanical shock . . . extra resistance to spalling, abrasion and fluxing . . . unusually low porosity and shrinkage . . . extremely low coefficient of expansion. For longest satisfactory refractory service at highest temperatures, it pays to insist on refractories made of or fortified with Alcoa Alumina.

Alcoa Aluminas offer efficient, economical solutions to a host of processing problems. Their performance is backed by years of painstaking research, laboratory testing and field experience. Complete data on their properties and applications is available from Alcoa in the technical paper, *Alumina Properties.*

Other Alcoa Chemicals include Gallium and Fluorides. Detailed information on their properties and applications is available on request.

☆ ☆ ☆

Alcoa's many years of experience and research have created a vast fund of practical information to assist you in solution of your processing problems. Alcoa's development engineers will be happy to work closely with you in solving such problems as . . . corrosion control . . . proper design and fabrication of aluminum parts and assemblies . . . most effective use of the proper type and grade of alumina for your process needs.

For engineering assistance—or for detailed literature covering any of the aluminum or alumina applications mentioned above—write ALUMINUM COMPANY OF AMERICA, 883-J Alcoa Building, Pittsburgh 19, Pennsylvania.

ALCOA ALUMINUM
ALUMINUM COMPANY OF AMERICA

THE ALCOA HOUR
TELEVISION'S FINEST LIVE DRAMA
ALTERNATE SUNDAY EVENINGS

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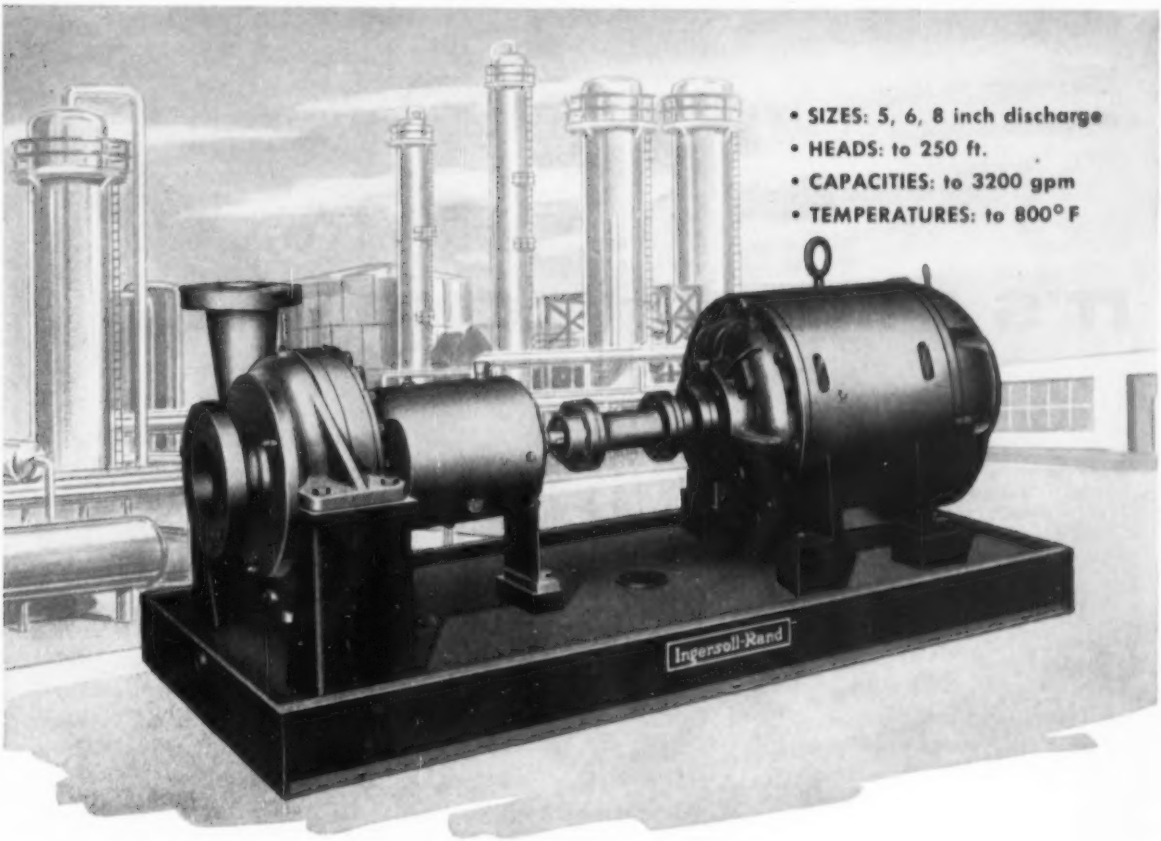
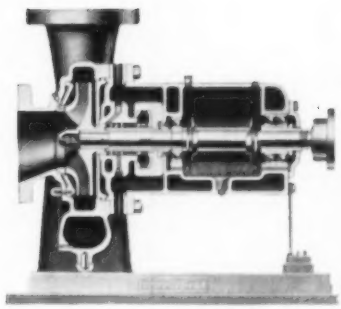


BUILT TO DO THE JOB

in large capacity slurry pumping



Ingersoll-Rand closed-impeller Class BSFL slurry pump arranged for injection at the vertical ring fit.

Ask for Bulletin 7094-B

Ingersoll-Rand's vertically-split, Class BSFL, refinery pump shown above has established an enviable record for continuous, dependable performance.

Available in conventional or special slurry pump construction, it is recommended wherever large capacities are required at medium operating heads. Here's the pump you'll find in wide use for bottom circulation or slurry service.

As a slurry pump, the unit can be furnished with either open or closed impeller. Both types have renewable shrouds that protect the casing at front and rear of impeller, and an adjustable thrust bearing journal sleeve to maintain proper clearance with the front shroud or casing ring. A flushing connection to the throat bushing provides for clean oil injection, minimizing packing and sleeve wear.

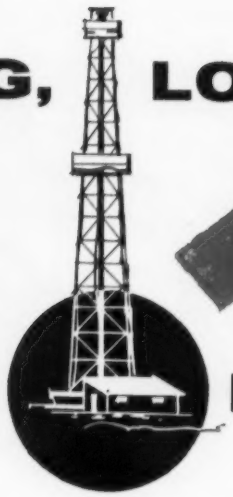
Let our engineer give you complete details about these and the many other pumps in our complete refinery line.

Ingersoll-Rand IR

10-377 11 BROADWAY, NEW YORK 4, N.Y.

PUMPS • COMPRESSORS • ROCK DRILLS • VACUUM EQUIPMENT • CONDENSERS • AIR AND ELECTRIC TOOLS

IT'S A LONG, LONG WAY...



FROM HERE

TO HERE!

For more data on advertised products, use Readers' Service Cards, last page.

Geographically, from the source of crude to the ultimate application of the final refinery product may be half a world . . . or only a few miles. 10 miles or 10,000 miles, you can be sure that the finished product has come a long, long way.

The demand for better motor fuels created by the continuing improvement of the modern automotive engine is a constant challenge to the refining industry to keep this road from reaching impractical or impossible lengths.

For over 40 years, the research and engineering staffs at Universal have been helping refiners meet this challenge by consistently developing, and making available to the entire industry, improved processes for producing products from petroleum.

No matter the brand name of the finished product, chances are its journey from well to gas tank was helped along by one or more UOP processes. Refiners, all around the world, are using them to provide better products, more efficiently and with significant economy.

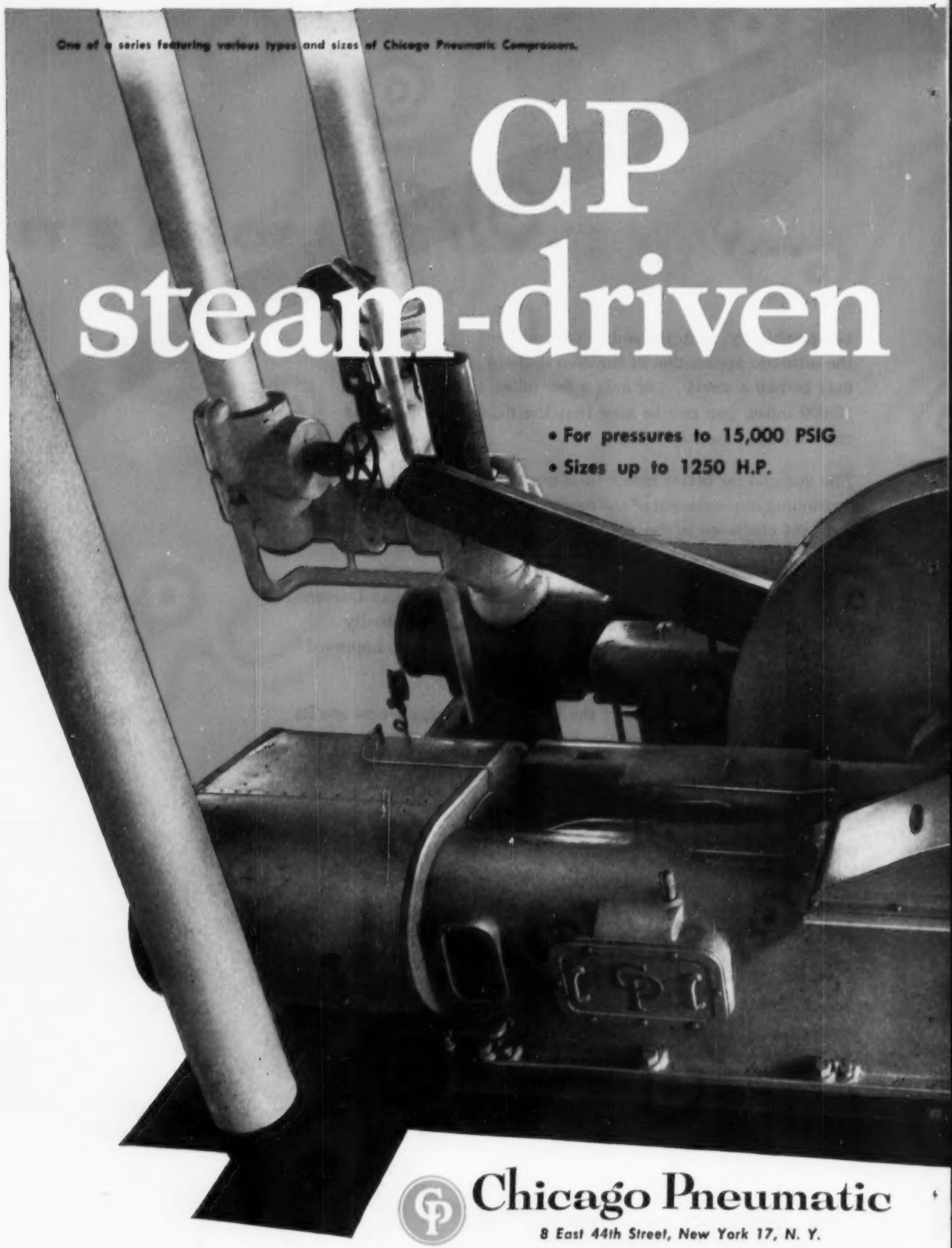
UNIVERSAL OIL PRODUCTS COMPANY

30 ALGONQUIN ROAD,
DES PLAINES, ILLINOIS, U. S. A.

Forty Years of Leadership In Petroleum Refining Technology

For more data on advertised products, use Readers' Service Cards, last page.

One of a series featuring various types and sizes of Chicago Pneumatic Compressors.



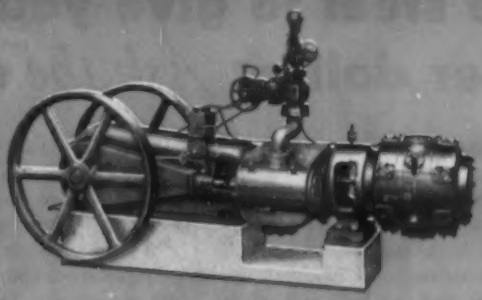
CP steam-driven

- For pressures to 15,000 PSIG
- Sizes up to 1250 H.P.

Chicago Pneumatic

8 East 44th Street, New York 17, N. Y.

AIR AND GAS COMPRESSORS • VACUUM PUMPS • PNEUMATIC TOOLS • ELECTRIC TOOLS • DIESEL ENGINES • ROCK DRILLS • HYDRAULIC TOOLS



Class T single-stage, horizontal, straight-line, steam-driven compressor. Also available in two- and three-stage designs.

compressors

...for the process industries

Class H, four-corner, steam-driven, single-stage gas booster compressor.

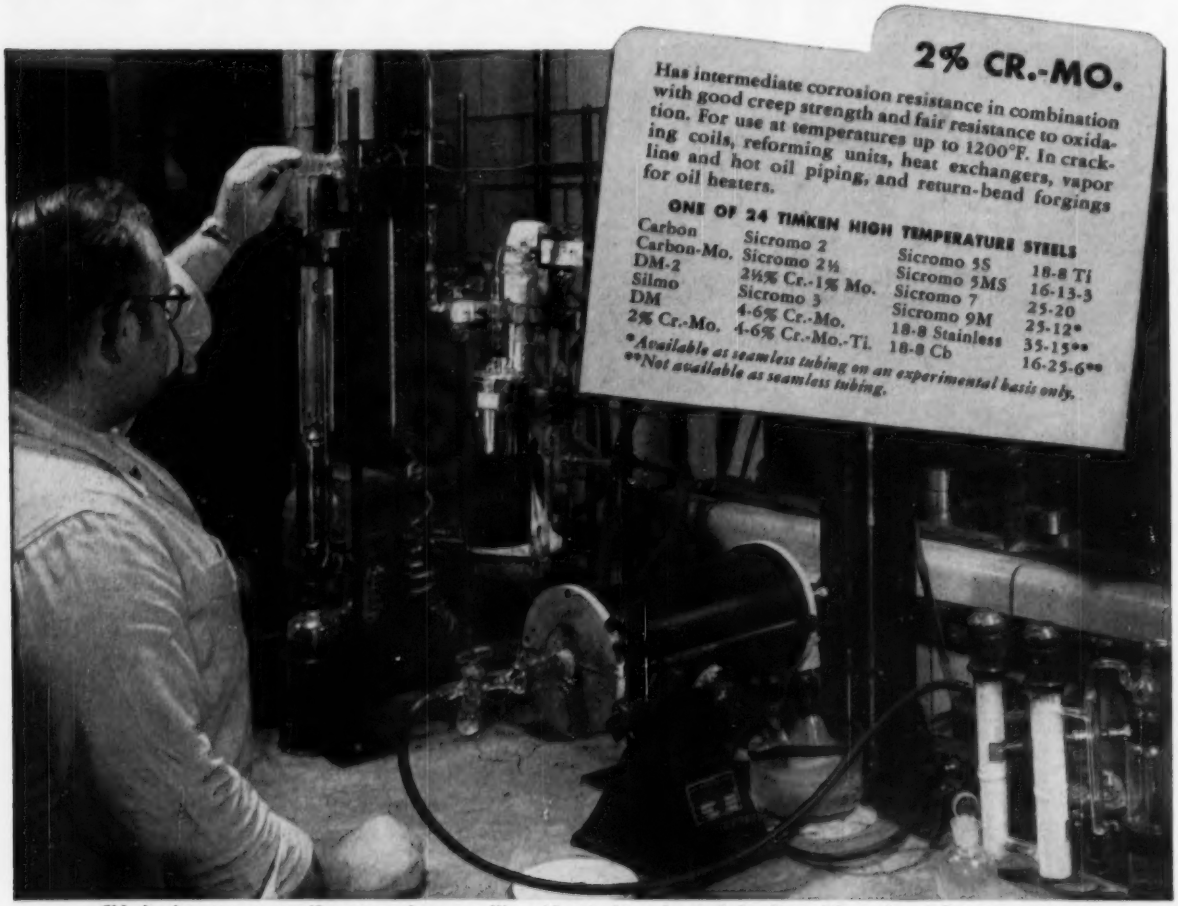
For more data on advertised products, use Readers' Service Cards, last page.

For the one tube steel to give you the longest tube life per dollar: *Ask the experts!*

CHANCES are that there are several different analyses of tube steel that could solve your particular combination of heat, corrosion, pressure and oxidation problems. But there is only *one* steel that can give you the lowest tube cost per year of required service—the best life/cost ratio.

To find that one steel, *ask the experts!* Ask the Timken Company metallurgists, recognized authorities on high temperature steel tubing. When you consult these experts, you get the benefit of over twenty years' experience with high temperature steels. From the wide range of Timken® fine alloy steels, they can help you select the one that is best for your requirements. And whatever analysis you choose, you'll be assured of uniform high quality. The quality of Timken steels is controlled from melt shop through to the final inspection with the most exacting methods.

Let Timken Company metallurgists help you solve your tubing problems. *Ask the experts!* The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".



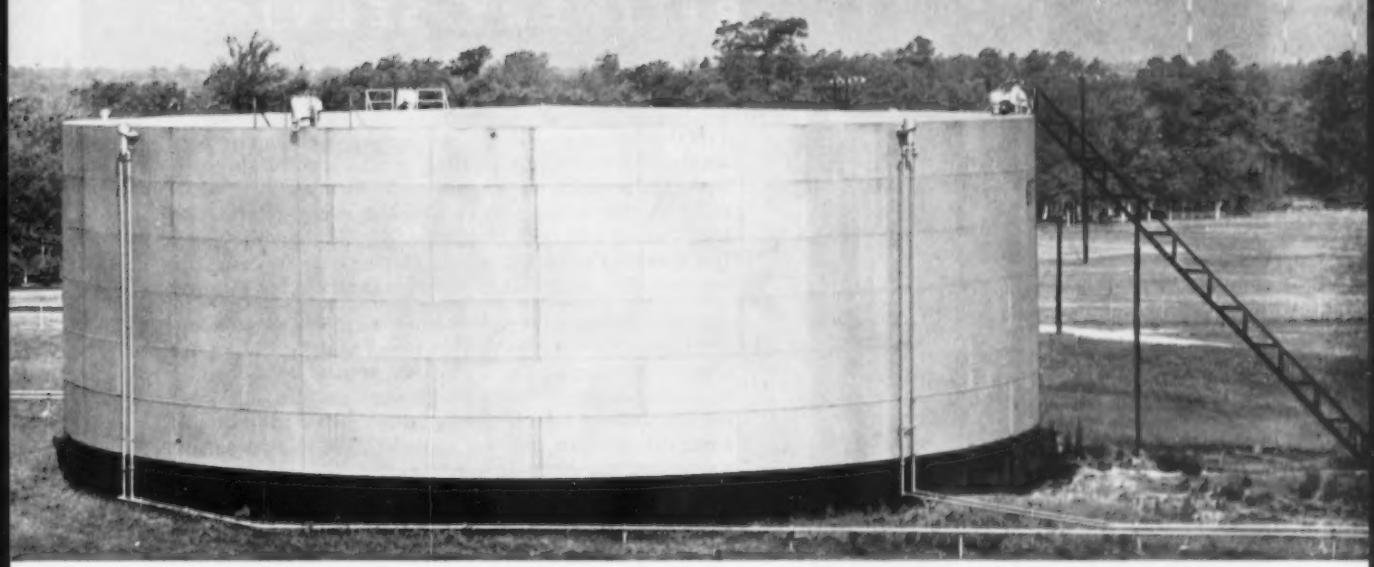
Chlorination apparatus purifies extracted non-metallic residues to determine steel cleanliness. It's another of the many aspects of high temperature steel research in constant progress at the Timken Company.

See us at the NATIONAL METALS EXPOSITION, Oct. 8-12, Public Auditorium, Cleveland, Ohio, BOOTH 1051

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING

Sinclair tank reduces evaporation every working hour

with Microballoon spheres*



Test tank has a discharge rate of 2000 bbl. per hour, with five turnovers per month. Average temperature is 75 deg. F, RVP is 5.6 psi. Since its evaporation loss was about half that of the control tank, additional tanks at this **Sinclair Refining Co.** location are due for this system of evaporation control.

For more than two years, Sinclair Refining Co. has had one of its older 80,000-bbl. cone-roof tanks at Houston, Texas, equipped with a vapor-stopping seal of Microballoon® spheres made from BAKELITE Brand Phenolic Resins.

Results of this test now show that evaporation loss was approximately half that of the control tank, which had no seal.

The effective use of the foam seal treatment can help you reduce needless waste due to evaporation.

To learn more about this method of control, write Bakelite Company, or *Chicago Bridge & Iron Company, Chicago 4, Ill.*

for evaporation control . . .

BAKELITE BRAND RESINS

*Registered trade-mark of The Standard Oil Co. (Ohio)

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.
In Canada: Bakelite Company, Division of Union Carbide Canada Limited, Belleville, Ontario

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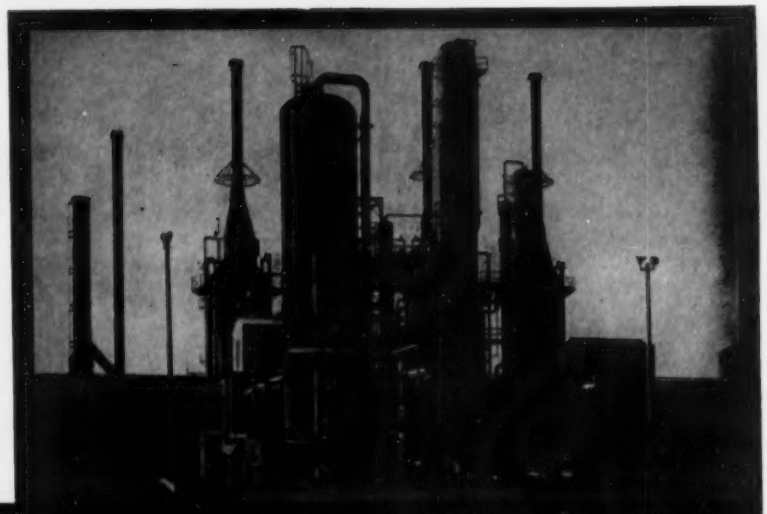
TO INSURE

smooth operations
more time on stream
lower operating costs
better products



TRETOLITE REFINERY SERVICES

DESALTING

CORROSION PREVENTIVES

FUEL EMULSION PREVENTIVE

METAL DEACTIVATOR

Desalting the crude charge before refining is now accepted as standard operating procedure. Desalting removes salts which evolve into corrosive acids. It prevents salt plugging of condensers, exchangers and towers, and keeps solids and fines from entering the refinery. Tretolite desalting is an automatic, all chemical process, consistently delivering salt removals in the 98 to 100% range.

Kontol Corrosion Preventives combat internal corrosion, hydrogen blistering, fouling and scaling. They are organic semi-polar liquids which protect by adsorbing at metal surfaces as a tough, impervious film. They are readily adsorbed from dilute hydrocarbon solutions to form this film. In addition to their corrosion preventive properties, the Kontols are powerful detergents which clean and de-foul refining equipment.

Tretolite Fuel Emulsion Preventive is an organic, oil-soluble agent designed to prevent the emulsification and sludging of burning oils and diesel fuels. Oils treated with Tretolite Fuel Emulsion Preventive have shown no sludge formation even after a three month settling test.

Kuplex Metal Deactivator effectively deactivates copper in hydrocarbons such as gasoline, kerosine, jet fuel, diesel oil, furnace oil and turbine oil. Its powerful chelating action prevents hydrocarbon deterioration caused by metal catalyzed oxidation.

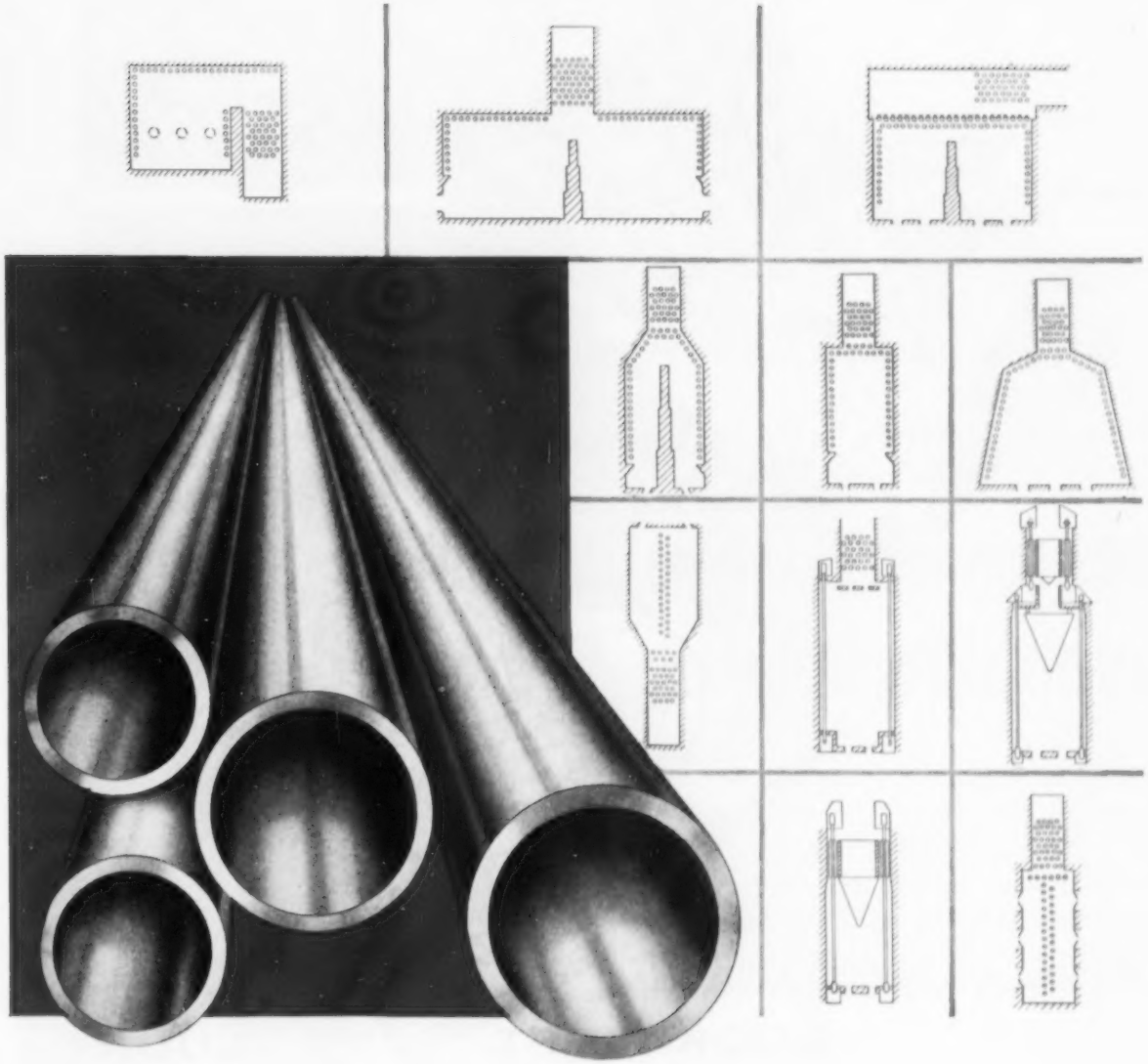
For complete information, technical data and prices, ask your Tretolite refinery service engineer or write to –

TRETOLITE COMPANY
A DIVISION OF PETROLITE CORPORATION
369 Marshall Avenue, Saint Louis 19, Missouri
5515 Telegraph Road, Los Angeles 22, California

TD 56-12

Chemicals and Services for the Petroleum Industry

DESALTING • DEMULSIFYING • CORROSION PREVENTING
SCALE INHIBITING • FUEL OIL ADDITIVES • WATER
DE-OILING • PARAFFIN REMOVING • PRODUCTION
STIMULATING • BACTERICIDES • METAL CONDITIONERS



DESIGN ADDITIONAL SERVICE LIFE
INTO YOUR PROCESS HEATERS

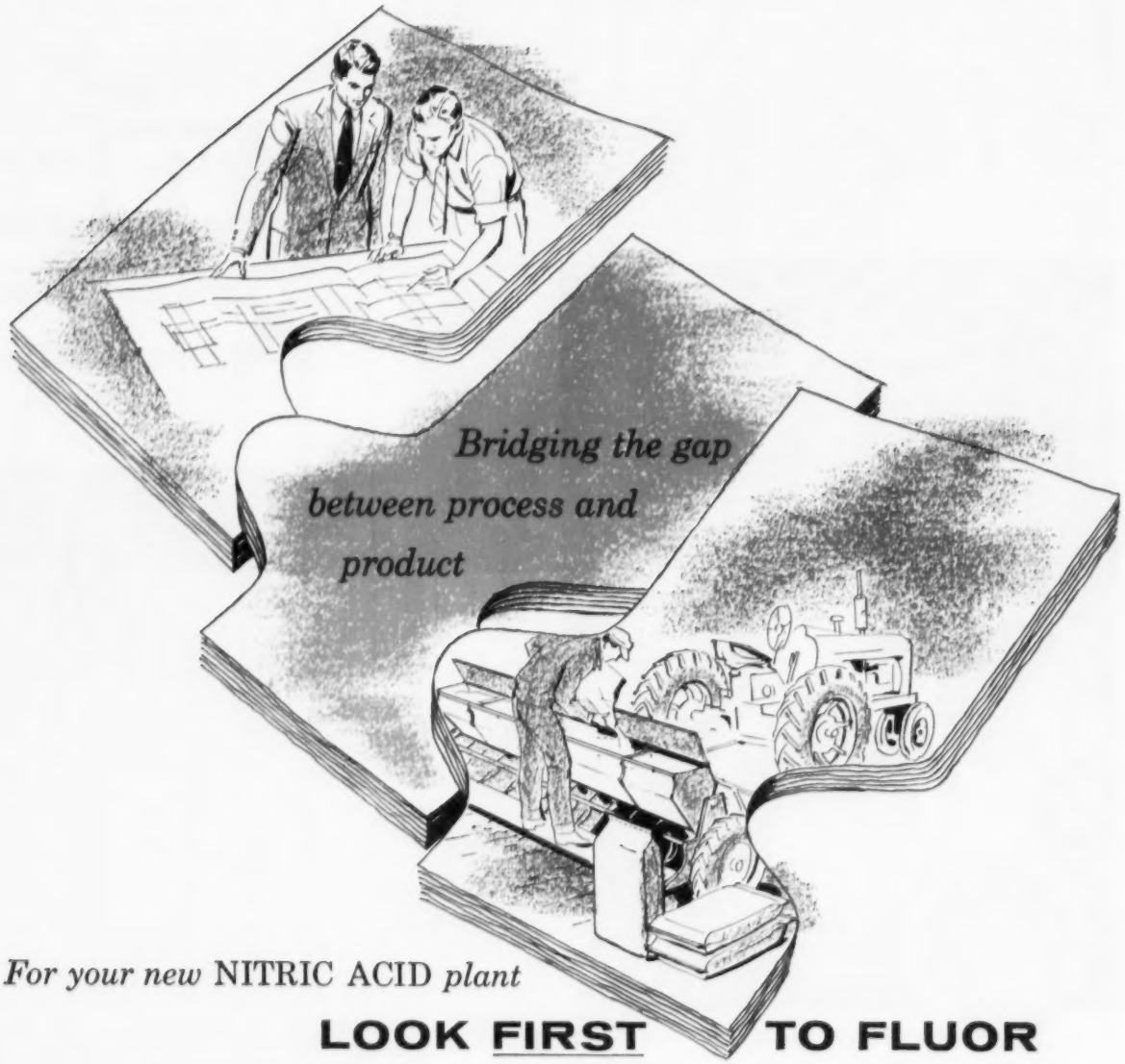
...with B&W TUBING

Long service life of process heater tubing for the oil refining and petrochemical industries dictates selection of a B&W Croloy to insure maximum corrosion and oxidation resistance, and fully satisfactory handling of unusual temperature and pressure conditions which may arise. Mr. Tubes —your friendly link to B&W—has facts and figures to help you choose the best tube for the job. Get in touch with him to discuss your heater tube requirements, for both original equipment and maintenance. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

TA-6062(P)

Seamless and welded tubular products, seamless welding fittings and flanges—in carbon, alloy and stainless steels

For more data on advertised products, use Readers' Service Cards, last page.



For your new NITRIC ACID *plant*

LOOK FIRST TO FLUOR

For new nitric acid production facilities, you can now call on Fluor, licensed to design and construct plants based on the DuPont Pressure Process. Fluor's long experience in the process industries is your insurance of a nitric acid production facility with low initial cost and trouble-free operation. The Fluor organization's complete integration permits each project to be carried through all phases . . . design, procurement, and construction . . . under a single responsibility.

The process offered is economical and completely proven, using only three raw materials—air, ammonia, and distilled water. Capacity may be as low as 50 tons per day or as high as required. An integral energy-recovery system substantially reduces horsepower requirements, and the plants are characterized by minimum operating costs.

FLUOR

Engineers • Constructors

The FLUOR CORPORATION, Ltd.

Fluor's unique ability to see every project *as a whole* . . . the economic as well as the technical details . . . is described, along with process description and operating requirements, in a new folder, NITRIC ACID PLANTS. Write for your copy today.

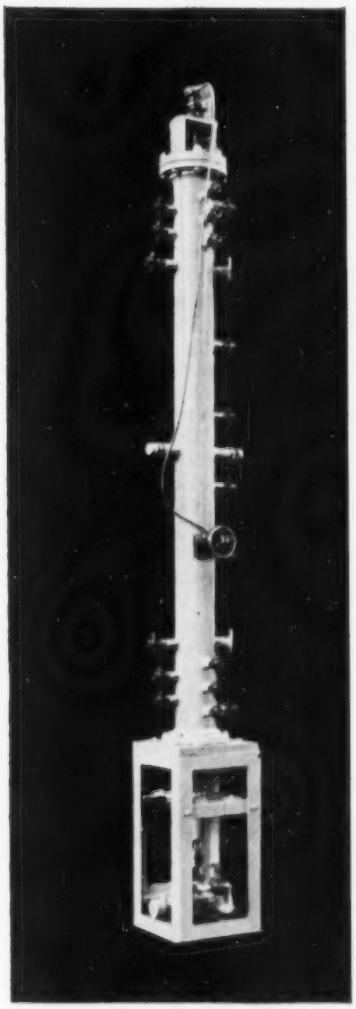
2500 So. Atlantic Boulevard, Los Angeles 22, Calif. • Offices in Principal Cities in the United States and Canada

Turbo-Topics

TURBO-MIXER GENERAL AMERICAN TRADE MARK

TURBO-MIXER, a division of

GENERAL AMERICAN TRANSPORTATION CORPORATION



Typical Turbo-Mixer R.D.C. Pilot Column (6" x 8'0") For Research or Design Studies

Pre-Testing Proves that the Turbo-Mixer R.D.C.* Column can solve Your Extraction Problems

Every extraction problem is a bit different. That's why you benefit from Turbo's eight years of research, piloting and industrial scale installations that provide a background of experience applicable to your problems.

Even more important, our laboratory is completely equipped to make specimen runs on your materials and develop reliable plant scale design. Your engineers are invited to observe these laboratory runs. Pilot scale equipment can be built for development studies at your own plant, if you so desire.

The R.D.C. extractor offers you:

1. ***High Volumetric Efficiency;***
2. ***High Thru-Put Capacity;***
3. ***Simplicity of Construction;***
4. ***Low Power Requirements;***
5. ***Flexibility of Operation.***

Our engineers are at your service for application of the R.D.C. to your extraction problem. For further information and descriptive bulletins, write today.

*Licensed under Shell Development Company Patent

SALES OFFICE: 380 MADISON AVENUE, NEW YORK 17, NEW YORK

General Offices: 135 S. La Salle St., Chicago 90, Illinois • Offices in all principal cities

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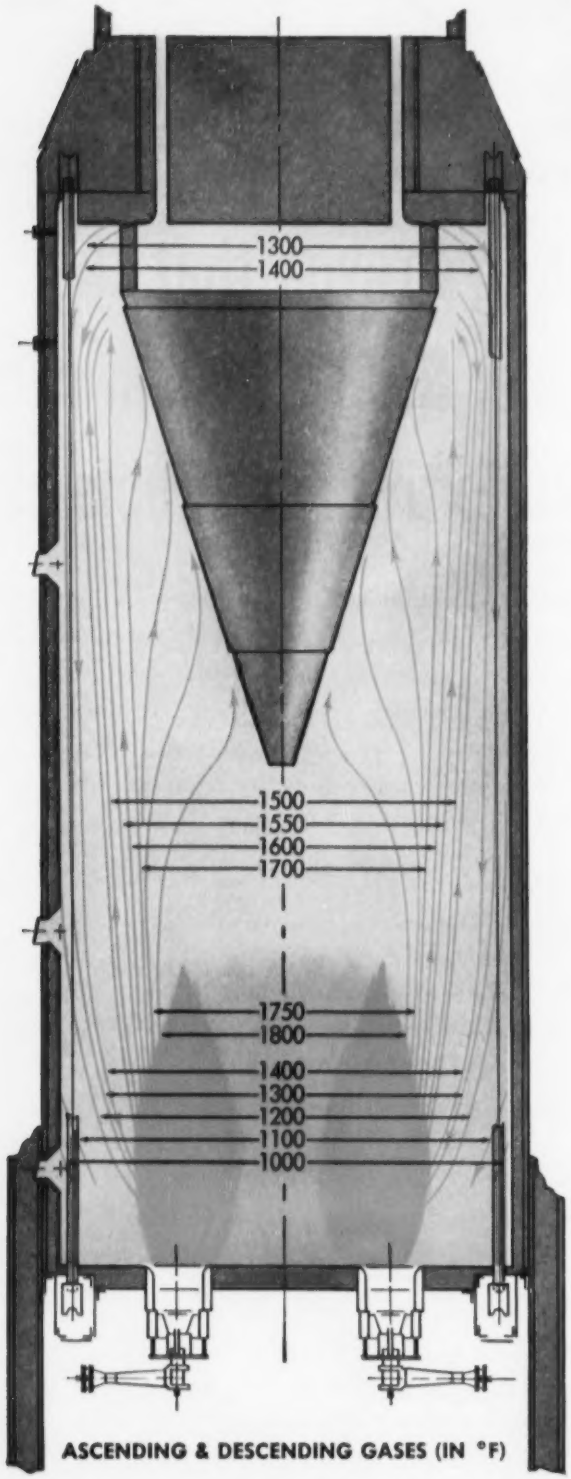
PETROCHEM-ISOFLOW FURNACES



ASCENDING & DESCENDING GASES (IN °F)

Here are the facts!

The first vertical cylindrical heaters provided even circumferential heat input, but vertical flux distribution varied considerably, from high transfer at the bottom of the tubes to low rates at the top. Improvements in design during the past twenty years have overcome this difficulty, by providing proper firebox proportions, a reradiating cone, and burners specifically designed to the requirements of the furnace.

It is significant that *only Petrochem-Isoflow furnaces* incorporate all three of these critical items of design.

The small, hot cone tip reradiates to the tubes, across a considerable distance. Because of the conical shape employed, each higher element of the cone is of larger area, and closer to the tubes than the section below. These factors compensate for decrease in cone temperature from tip to base, provide relatively constant radiant heat transfer over entire upper tube length.

The cone also serves to divert flue gases along the upper ends of tubes, which adds convection heat transfer over this length. It also initiates a high rate of firebox recirculation of combustion products, by cooling the gases in their passage across the tubes.

Being cooler, and therefore heavier than the rising gases in the center of the firebox, the gases adjacent to the tubes fall to the bottom of the heater by thermal siphon effect, increasing the heat input to the rear of the heating elements by convection. The descending gases also serve as a buffer between hot gases and the lower ends of the tubes and dilute the products of combustion. The special burners, by developing a symmetrical flame pattern, contribute to the equality of heat distribution over the entire radiant tube length.

Of the design features mentioned above, the cone is of the greatest significance because it is essential to even radiant heat distribution.

Experienced operators know that even heat distribution improves product quality, decreases tube deteriorations, results in longer, trouble-free operating cycles.

The Data Shown in the Drawings are ACTUAL PERFORMANCE RECORDS!

To check radiant flux distribution in Petro-Chem furnaces, exhaustive tests were made under actual operating conditions; some of the results of these tests are indicated in the two adjacent drawings.

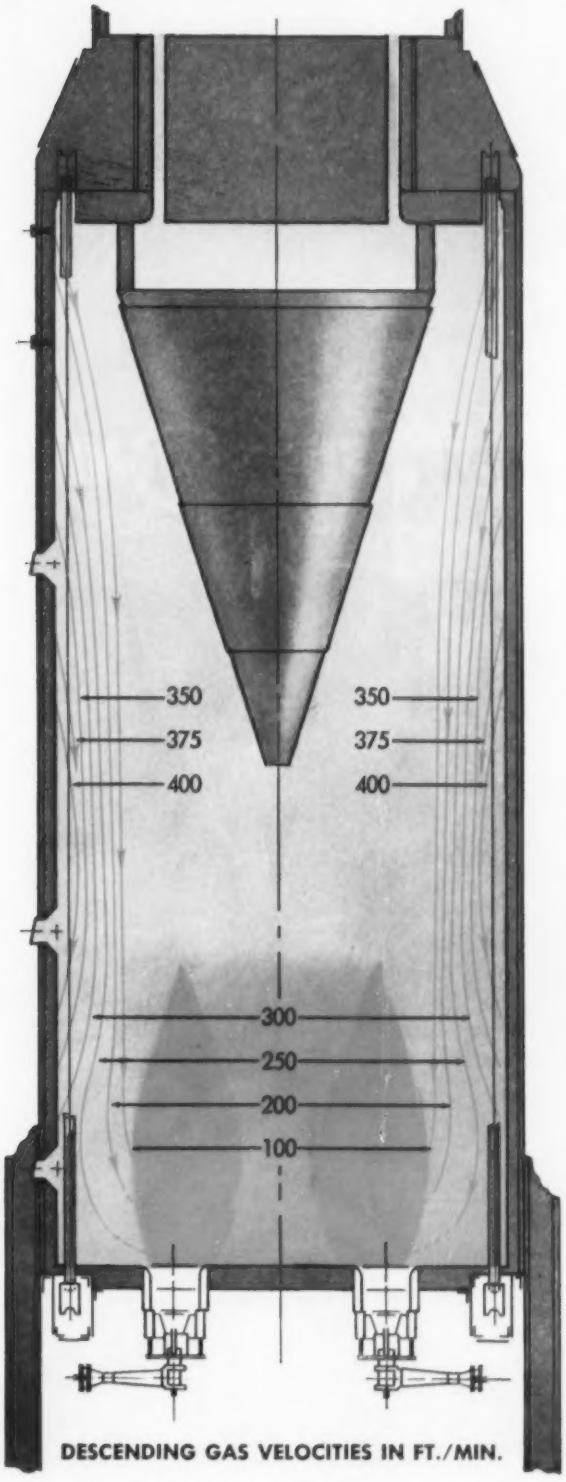
Left: Plot of isotherms in a Petrochem-Isoflow firebox, illustrating the uniformity of firebox temperature.

Right: Plot of flue gas flow patterns and velocities, demonstrating the high gas recirculation rates.

Both of these phenomena are the result of proper firebox proportions, the two-fold action of the cone, and symmetrical flame pattern.

For more data on advertised products, use Readers' Service Cards, last page.

Provide EVEN HEAT Distribution !



DESCENDING GAS VELOCITIES IN FT./MIN.

In addition to even heat distribution, other all-important factors which determine the value and efficiency of processing furnaces include:

MAXIMUM FUEL EFFICIENCY
PLENUM CHAMBERS FOR HAZARDOUS AREAS
SIMPLICITY OF DESIGN AND CONSTRUCTION
EXCESS DRAFT FOR HIGH OVERLOAD
EXPLOSION RESISTANT
MINIMUM GROUND SPACE
SHORT LENGTH OF LIQUID TRAVEL
ZERO AIR LEAKAGE
LOW PRESSURE DROP
LOW MAINTENANCE

In every case where these 11 all-important design characteristics were employed to compare one type of furnace design with another, PETROCHEM-ISOFLOW FURNACES were proved more economically desirable by any comparison.

More than 1350 Petrochem-Isoflow Furnaces have been installed since 1940—an unequalled record of acceptance based on proved performance.

PETROCHEM
—ISOFLOW FURNACES

UNLIMITED IN SIZE . . . CAPACITY . . . DUTY

PETRO-CHEM DEVELOPMENT COMPANY, INC.
122 East 42nd Street, New York 17, N. Y.

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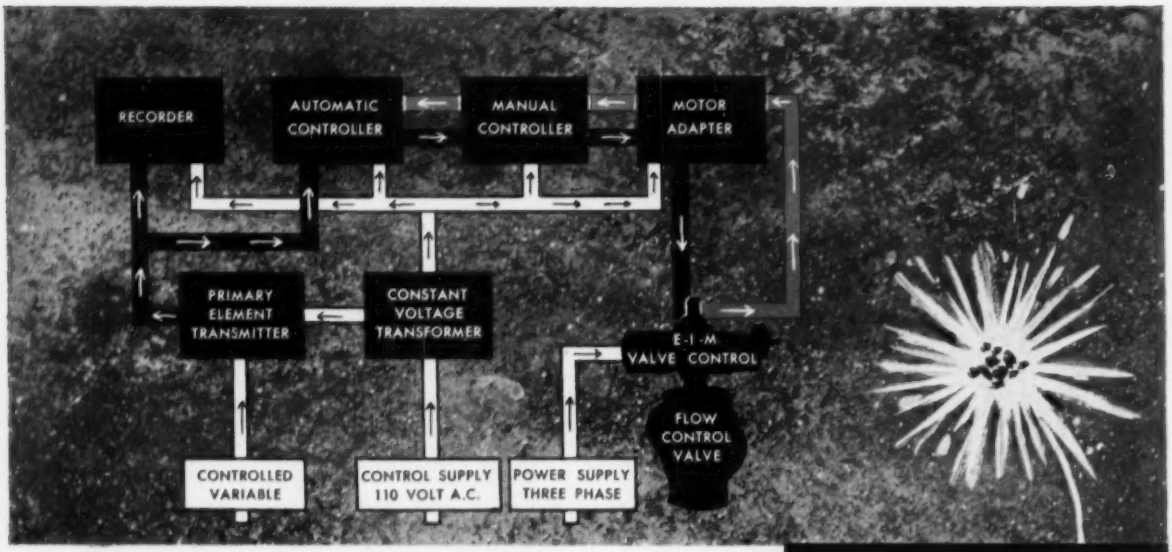


The valve control of the future TODAY

EIM

FUTRONIC

VALVE CONTROL

E-I-M FUTRONIC valve control, the first all electric power operator for actuating control valves in throttling and regulating services.

The fully flexible electronic control system, utilizing A.C., D.C., motion inputs as well as conventional primary elements, is highly suitable for process and power instrumentation.

The FUTRONIC valve control system is particularly valuable in meeting pipe line compressor station, pipe line pumping station and metering station requirements.

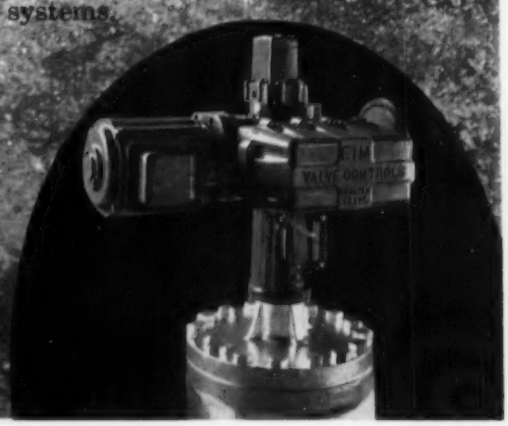
Units are adaptable for readout, cascading, computer and similar systems. Transmission distances of great length are permissible and it is possible to tie in with leased wire, micro-wave and other metering systems.

For complete details of the FUTRONIC valve control write

E-I-M

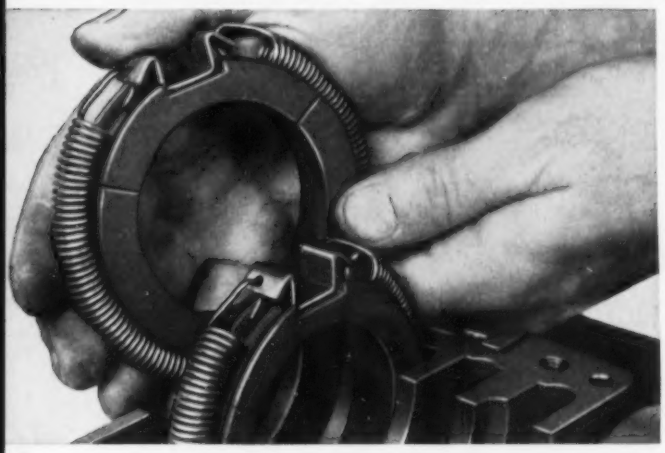
COMPANY, INCORPORATED

3840 Old Spanish Trail
Houston 25, Texas



On all General Electric High-speed Turbines,

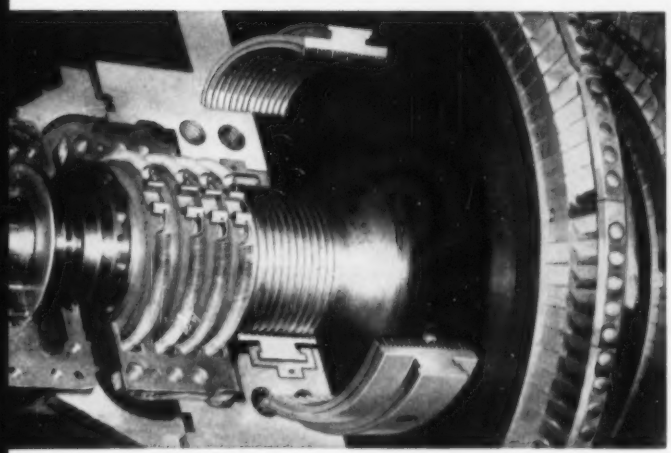
Well-designed, efficient seals...



Highly efficient, easily-replaced carbon packings

For the most effective shaft-end sealing, well-designed, low-cost carbon packings are used on G-E High-speed Turbines to seal steam pressures up to 75 psig. Made of non-galling, self-lubricating carbon-graphite, these segmental rings have high mechanical strength in the small sizes used, assuring long life under normal operating conditions. A garter spring in an offset "V" groove holds each ring together and presses it firmly against the side of the chamber, forming a tight seal. This unique arrangement permits the rings to support their own weight and to adjust themselves to the shaft position, thereby reducing wear and increasing the life of the seal. The rings are contained in compact external packing boxes, and can be easily inspected or replaced without breaking the horizontal joint of the wheel casing.

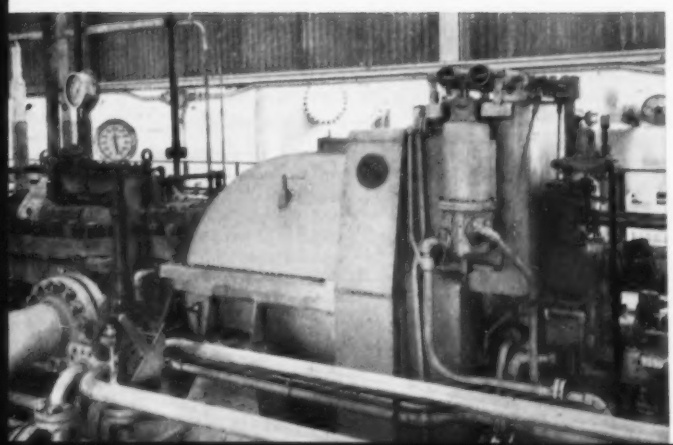
cut steam leakage...



Reliable, long-life metallic-labyrinth seals

To effectively minimize shaft-end steam leakage where shell pressures exceed 75 psig, segmental, high-low tooth metallic-labyrinth seals are used in combination with carbon packing. Between stages, straight-tooth metallic-labyrinth seals are always used. For maximum seal efficiency, minimum clearances between the teeth and the shaft are maintained by precision-machined hook fits in the packing housing. Shaft scoring is practically eliminated since the leaded-bronze segments are spring-backed and can move outward should there be accidental contact with the shaft. When unbalanced steam pressure forces axial movement of the seals, the shoulders of the rings and the housing engage to form a tight steam seal. All labyrinth seals are designed to compensate for thermal expansion, thus assuring a most efficient steam seal at operating temperatures.

reduce maintenance costs



The careful design and manufacture of these steam seals is your further assurance of low maintenance and consistent reliability of G-E High-speed Turbines. Why not check into the many other sound design features built into these mechanical drives? Your Apparatus Sales Representative will be glad to explain the many benefits they offer to your operation. Contact him for further information or write for Bulletin GEA-6232, General Electric Company, Section 241-7, Schenectady, N. Y.

Progress Is Our Most Important Product

GENERAL ELECTRIC

TAKE A TIP FROM

ON HANDLING TOUGH CORROSIVES!

USE **CHIKSAN**

LOADING ARMS

To maintain smooth production schedules, Eastman Kodak brings corrosive solvents and acids to its Rochester plant via truck from nearby tank farm storage. Corrosive action, however, was destroying loading hoses after comparatively short periods of use. To overcome this costly problem Kodak replaced its hoses with Chiksan Loading Arms. That was 10 years ago. Today, there are over 40 Chiksan Loading Arms in service at Kodak Park and not one record of product fatigue to date.

Whatever your fluid handling requirements, be it corrosive or other, insist on Chiksan Loading Arms—the time proven answer where the accent is on service, safety and speed.

There's a Chiksan Catalog waiting for you. Send for it today.

FOR CATALOG, WRITE DEPARTMENT 14-6

A SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION

fmc **CHIKSAN**

CHIKSAN COMPANY—BREA, CALIFORNIA • CHICAGO 5, ILLINOIS • NEWARK 2, NEW JERSEY

Well Equipment Mfg. Corp. (Division), Houston 1, Texas • Subsidiaries: Chiksan Export Company • Chiksan of Canada, Ltd.

DU PONT REG. U.S. PAT. OFF.

PETROLEUM CHEMICALS DIVISION

NEWS

DU PONT REG. U.S. PAT. OFF.

September ★ One of a Series of Bulletins for the Petroleum Industry ★ 1956

Question Box

1. ARE YOU RECEIVING shipment of additives in drums in less than carload lots?
   If so, you will certainly want to read about the four-figure savings you can realize by simply revising your ordering schedule. See article at right.
2. HOW MANY different economy-grade diesel fuel problems can you lick with a single additive?
   In the article below, you may be surprised at how much one additive can accomplish for you.
3. WHO at the Du Pont Petroleum Laboratory can help you make the most efficient use of gasoline additives?
   Read about him on the next page.
4. HAVE YOU called in a doctor recently—for helping your TEL blending personnel maintain their high standards of *safe* living?
   You can find out about this unique Du Pont medical service on the next page.

To help you overcome economy diesel fuel problems

Has the growing demand for economy diesel fuels created new problems for you? Three of the most common problems encountered by refiners are:

1. Incompatibility
2. Instability
3. Sparking tendency

Du Pont Fuel Oil Additive No. 2 (FOA-2) offers you a solution to all three.

It can help you gain the needed refining flexibility by making it possible for you to blend catalytic-cracked stocks with straight-run products, and overcome the incompatibility problem.

Stabilizer and dispersant

In actual railroad service, the stabilizing and dispersant action of FOA-2 has proved highly effective for reducing the tendency of many economy-grade diesel fuels to cause filter-plugging and injector-sticking.

How much can you save by ordering Du Pont additives in tank-car lots?

Refiners can save considerable money by ordering Du Pont additives in tank-car lots. For example, 4,000 gallons delivered in a tank car, rather than in drums in less than carload lots, will save the refiner between $1,680 and $2,400, as shown in this table:

ADDITIVES	GULF COAST		MID-CONTINENT		WEST COAST	
	$ Saving	% Saving	$ Saving	% Saving	$ Saving	% Saving
Du Pont Antioxidant No. 22	$2,250	6.7%	$2,250	6.7%	$2,400	7.0%
Du Pont Fuel Oil Additive No. 2	$1,680	8.3%	$1,710	8.4%	$1,850	8.9%
Du Pont Lube Oil Additives	$1,830	12.0%	$1,860	12.0%	$2,000	12.5%

Because of the difference in freight rates, the actual dollar savings vary according to the location of the refinery receiving shipment. But no matter where your refinery is located, you will find the savings decidedly worthwhile.

How much can YOU save?

To give you the exact figures, one of our nearby representatives

OVER

Locomotive sparking, a problem which is sometimes accentuated with economy fuels, results from the formation of carbon deposits – generally during idling or while coasting downhill. The ejection of these deposits when glowing, and the resulting fire hazard, may occur during runs under heavy load.

A metallic additive is likely to aggravate this situation by increasing the size and cohesiveness of the carbon deposit particles. Field tests show, however, that an *ashless* additive does not contribute to the sparking problem. Rather, it tends to minimize it.

Du Pont FOA-2, therefore, being an *ashless*, nonmetallic additive, can help you reduce any sparking tendency in economy-grade diesel fuels.

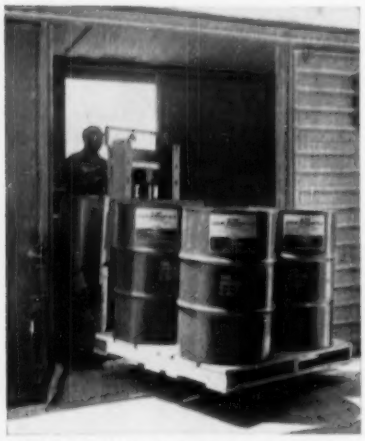
ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

PETROLEUM CHEMICALS DIVISION
NEWS

CONTINUED

Tank-car lots

will be glad to call at your refinery, study your freight rates and inventory patterns. He will then determine the most convenient handling method for you and figure the exact saving you can make. You can write, wire or phone him at our nearest sales office listed below. Why not do it now?



IN ADDITION to the dollars you save on the delivered cost of the additives, you can save on handling costs by receiving additives shipments in tank-car lots.

LABORATORY GROUP HEAD

In number of miles, the distance between Havertown, Pennsylvania and Wilmington, Delaware is not far, unless, as Harold Scheule did, you go by way of Bartlesville, Oklahoma.

Scheule, who is supervisor of the Gasoline and TEL Group at the Petroleum Laboratory, was born in Havertown in 1921. Following his graduation from Bucknell University in 1943, with a B.S. in Chemical Engineering and a Phi Beta Kappa key, Harold joined the Bartlesville staff of Phillips Petroleum Company, where he remained until 1946. Since then he's been with Du Pont at the Petroleum Laboratory.

His professional affiliations include membership in the American Institute of Chemical Engineers and the American Chemical Society. He is also active in the Coordinating Research Council.

HAROLD J. SCHEULE

Du Pont medical representatives teach safety as a way of life

Hurrying back and forth across the country, and traveling overseas, too, Dr. Stewart L. Rankin covers more than 50,000 miles a year. In the course of his travels, he has firmly impressed upon more than 20,000 refinery workers his famous slogan, "Safety is a way of life!"

DR. RANKIN is shown at right with Doctors Fenton Russell (left) and L. A. Gerlach, all of the Du Pont Medical Division.

His talks on safety are part of a unique medical service which Du Pont, as a supplier of tetraethyl lead, makes available to the oil industry. In addition to the talks, Dr. Rankin and his medical associates work closely with refinery managements, physicians, supervisors and blenders to help them maintain the very finest health and hygiene programs. Practicing *preventive* medicine, the Du Pont doctors will tell you emphatically that their greatest ambition is that they *never* have to treat a case of lead poisoning.

To help them achieve this ambition, we hope you will feel free to take advantage of their services – often!

DU PONT

Better Things for Better Living
. . . through Chemistry

Petroleum Chemicals

E. I. DU PONT DE NEMOURS & COMPANY (INC.) *Petroleum Chemicals Division* • *Wilmington 98, Delaware*

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ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

A-2338

Printed in U. S. A.

Kill Algae

NEW, easy, low-cost way

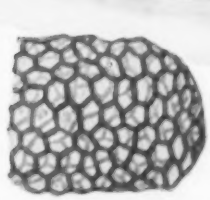
New Allis-Chalmers No. 120 Series Algaecide most toxic to all organisms in cooling towers

Many toxic materials used as algaecides are either difficult to handle (as in chlorination) or are effective against certain organisms, but not others. Fouling of cooling tower systems by algae and slimes results.

New No. 120 Series Algaecide succeeds when copper sulfate, potassium permanganate, quaternary ammonium compounds, sodium pentachlorophenate, and other complex chemicals offer only a partial solution to fouling conditions.

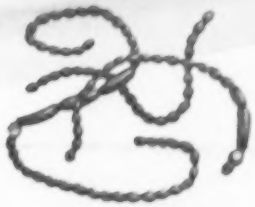
For complete information, call your A-C office, or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin, for Bulletin 28X8434.

As little as 2 ppm has killed all these algae

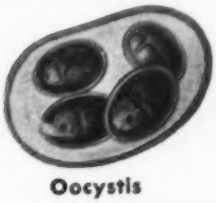


Hydrodictyon

Microcystis

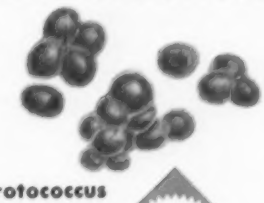


Anabaena



Oocystis

Chlorella



Protococcus

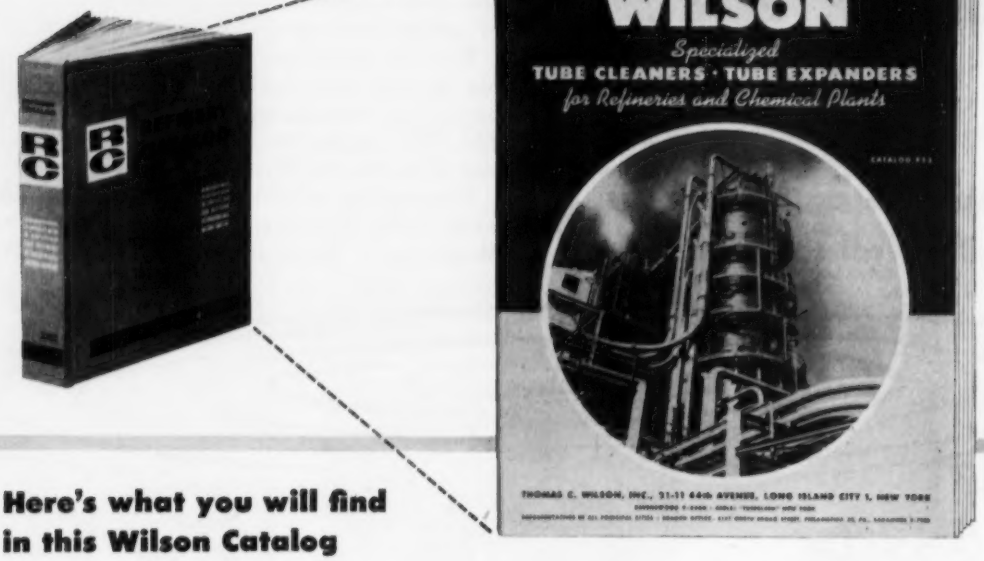
ALLIS-CHALMERS

A-5101

For more data on advertised products, use Readers' Service Cards, last page.

Look for it here

12 pages of helpful selection data



Here's what you will find in this Wilson Catalog

- **Air Motors** *for straight tubes*
- **Cutter Heads**
- **Pipe Cleaners**
- **Sleeves**
- **Hose and Couplings**
- **Air Valves**
- **Tube Cleaners** *for fouled heat exchanger tubes*
- **Air or Water Driven Motors** *for removal of spent catalyst*
- **Refinery Tube Expanders** *for refinery type fittings*
- **Tube Expanders** *for condenser and heat exchanger tubes*
- **Heat Exchanger Maintenance Tools and Products**
- **Condenser Tube Inserts**
- **Accessories** *for boiler erection and maintenance*

THOMAS C. WILSON, INC.

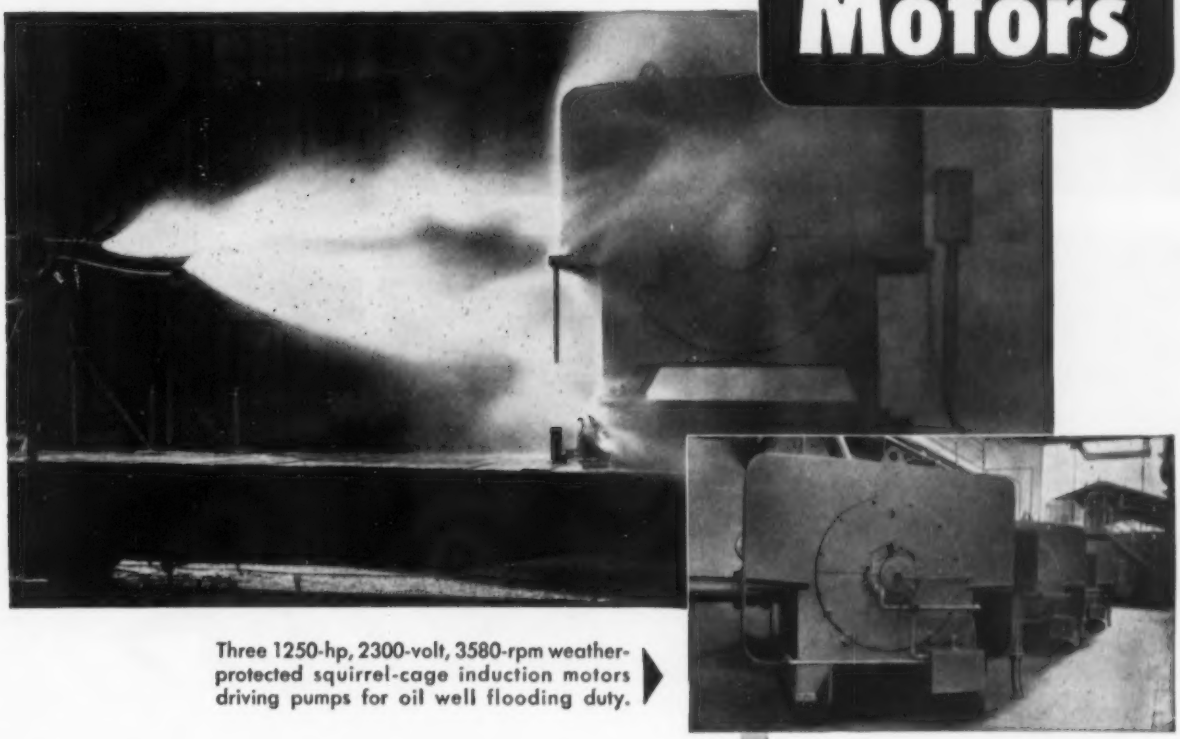
21-11 44th Avenue, Long Island City 1, New York • Representatives in all principal cities

TW865

For Positive All-Weather Protection

Neither wind-driven rain nor sand could penetrate the baffled ventilating system of this Allis-Chalmers Weather-Protected Squirrel-Cage Motor.

ALLIS-CHALMERS Motors



Three 1250-hp, 2300-volt, 3580-rpm weather-protected squirrel-cage induction motors driving pumps for oil well flooding duty.

Here's what we mean by protection! The roughest tests we could devise — wind-driven water equal to a 40-inch-per-hour rainfall, sand at velocities reaching 75 mph — failed to penetrate the vital areas of this Allis-Chalmers weather-protected squirrel-cage motor.

This tested and operation-proved design utilizes the same rugged construction features and engineering experience that make Allis-Chalmers motors the standard in the petroleum industry for performance and reliability.

Weather-protected motors are but part of the complete line of motors Allis-Chalmers builds for pipe line and refinery service. For more information, see your local A-C representative or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wis.

A-4908

Silco-Flex is an Allis-Chalmers trademark.

NOW, Even Greater Winding Protection with Revolutionary

Silco-Flex

all-silicone-rubber motor insulation. Available on many of the larger size Allis-Chalmers motors. For further information, ask your Allis-Chalmers representative.

ALLIS-CHALMERS

For more data on advertised products, use Readers' Service Cards, last page.

Have You a Special Heat Transfer or Chiller Problem?

My Problem is Surface Fouling!

Vogt has the answer in the positive flow-thru Scraped Surface Exchanger. Surfaces are swept clean by the rotating scraper action, eliminating the headache of fouled heat transfer surfaces.

We Have A Tough Crystallization Problem!

Because Vogt Scraped Surface Exchangers maintain uniform heat transfer rates crystallization is under control at all times. The rotating blades free the crystals from the walls and they are discharged as a slurry.

Our Product Must Be Mixed As It Flows!

Chemical Processors are particularly happy with the Vogt Scraped Surface Exchanger, because the product is thoroughly mixed by the rotating scraper blades as it flows.

Our Solvents are Dangerous to Use-Expensive to Lose!

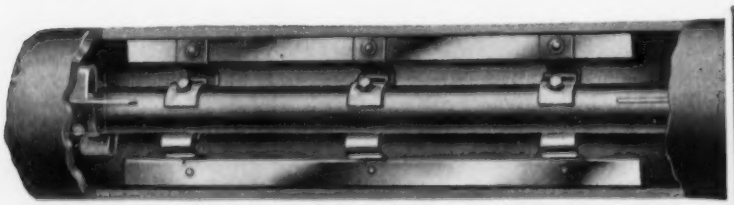
Vogt Scraped Surface Exchangers are closed, pressure-type systems which permit the use of flammable, volatile and expensive solvents with complete safety and no danger of solvent loss.

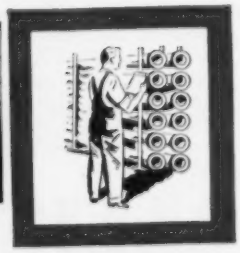
Vogt

Send for Bulletin PE-1 today. Address Dept. 24-RIPR

Has the answer in its Scraped Surface Exchangers

OTHER VOGT PRODUCTS: Drop Forged Steel Valves, Fittings and Flanges in a complete range of sizes • Petroleum Refinery and Chemical Plant Equipment • Steam Generators • Heat Exchangers • Ice Making and Refrigerating Equipment.





HENRY VOGT MACHINE CO., P. O. BOX 1918, LOUISVILLE 1, KY.

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Philadelphia, St. Louis, Charleston, W. Va., Cincinnati, San Francisco

For the petroleum industry...

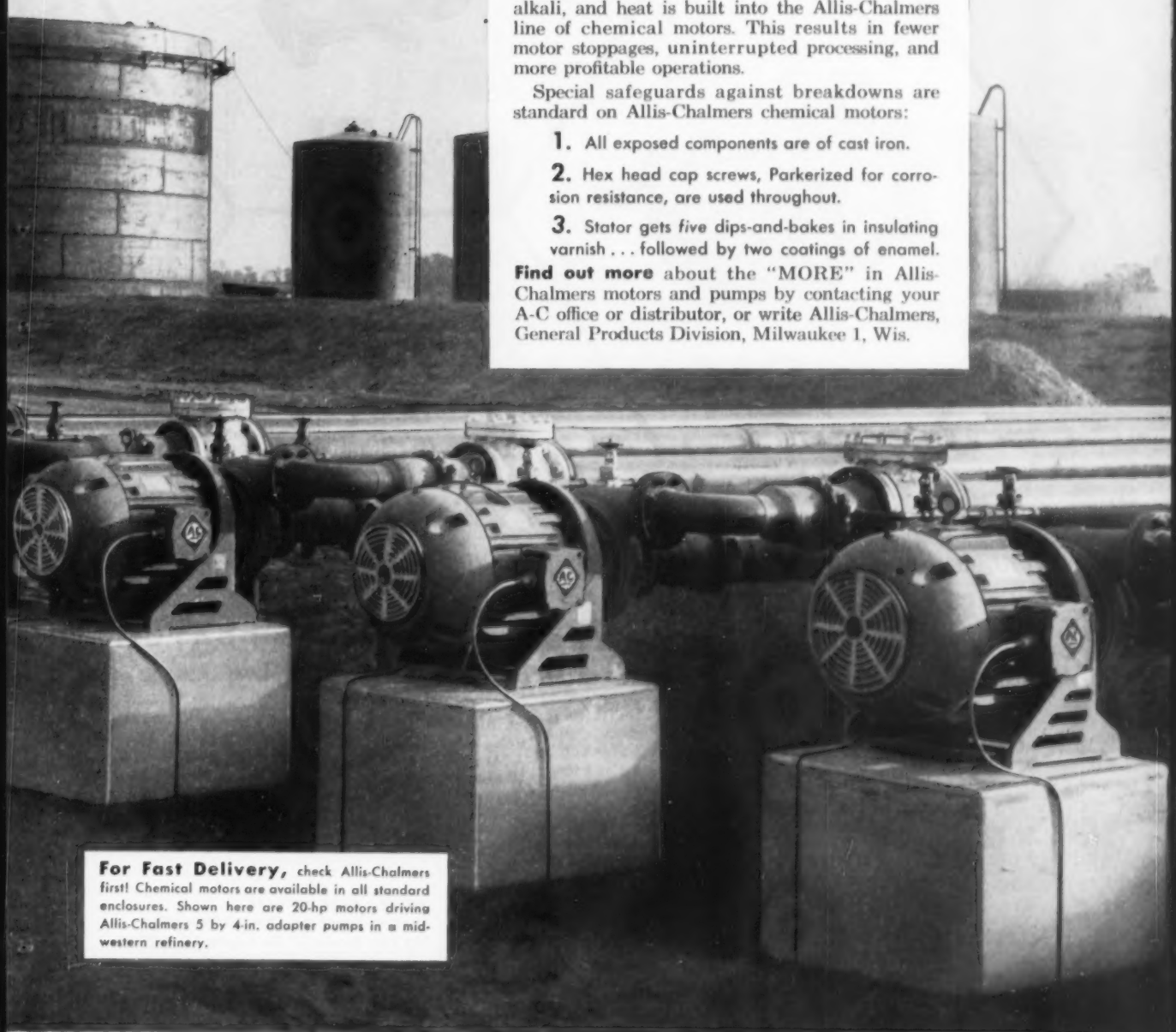
There's MORE continuous processing with Allis-Chalmers chemical MOTORS and PUMPS

Maximum protection against moisture, acid, alkali, and heat is built into the Allis-Chalmers line of chemical motors. This results in fewer motor stoppages, uninterrupted processing, and more profitable operations.

Special safeguards against breakdowns are standard on Allis-Chalmers chemical motors:

1. All exposed components are of cast iron.
2. Hex head cap screws, Parkerized for corrosion resistance, are used throughout.
3. Stator gets *five* dips-and-bakes in insulating varnish . . . followed by two coatings of enamel.

Find out more about the "MORE" in Allis-Chalmers motors and pumps by contacting your A-C office or distributor, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wis.



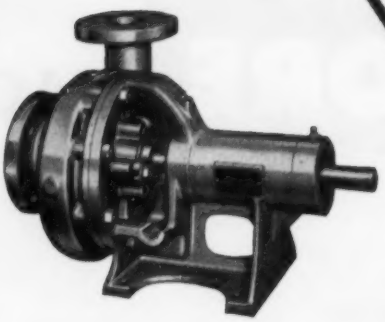
For Fast Delivery, check Allis-Chalmers first! Chemical motors are available in all standard enclosures. Shown here are 20-hp motors driving Allis-Chalmers 5 by 4-in. adapter pumps in a mid-western refinery.

ALLIS-CHALMERS

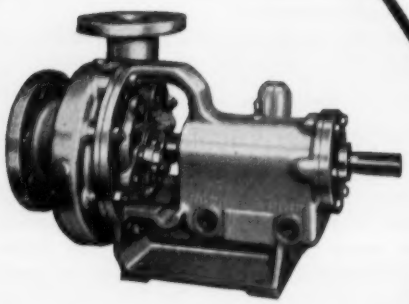
A-5160

Mr. Engineer: Cut Your Pump Inventory—Reduce Costs With These New, Proved Pumps

PEERLESS
CHEMICAL PROCESS PUMPS



type **DL**
grease lubricated housing



type **DM**
oil lubricated housing

Here is
INTERCHANGEABILITY IN ACTION—

Interchangeability of component parts for DL-DM pumps is graphically shown in this new Bulletin. Write for your copy. It shows how liquid end components are accommodated on either grease lubricated or oil lubricated bearing housings. Also provides quick reference to pump specifications and performance characteristics.

a new concept of economy through interchangeability of components!

PEERLESS
type DL & DM PROCESS PUMPS ALSO FEATURE:

ACCESSIBILITY—Through ease of assembly and disassembly if and when required. **DURABILITY**—Through use of any machinable metal as materials of construction. **SERVICEABILITY**—Through designs that feature maximum ease of maintenance. **INTERCHANGEABILITY**—Through a choice of semi-open or enclosed impellers, oil or grease lubrication, air-or water-cooled back plates and bearing housings. **RELIABILITY**—Through the high performance standards set for these pumps, proving more than ever before, that Peerless Builds Dependable Pumps. **AVAILABILITY**—Through shipment from stock of both complete pumps and pump components.

Other pertinent Type DL-Type DM facts:

Peerless Type DL and Type DM process pumps are available in 1", 2", 2½" and 3" sizes on an 8½" frame and in 1", 2", 2½", 3" and 4" sizes on a 10½" frame. **CAPACITIES**: up to 800 gpm. **HEAD RANGE**: up to 430 feet. **DRIVES**: motor or steam turbine. **TEMPERATURE RANGE**: grease lubricated housing up to 250°F.; oil lubricated housing up to 450°F. **WORKING PRESSURES**: up to 400 psig.

Write for your New Bulletin now. Use coupon for quick action.

PEERLESS PUMPS

PEERLESS PUMP DIVISION
FOOD MACHINERY AND CHEMICAL CORPORATION

Factories: Indianapolis 8, Indiana and Los Angeles 31, California
Offices: New York, Chicago, St. Louis, Atlanta, Lubbock and Plainview, Texas; Fresno, Los Angeles, Phoenix, Albuquerque.
Distributors in Principal Cities. Consult your local Telephone Directory.

fmc FOOD MACHINERY AND CHEMICAL CORPORATION

PEERLESS PUMP DIVISION
Food Machinery and Chemical Corporation
301 West Avenue 26, Los Angeles 31, California

Please send chemical process pump Bulletin No. B-1608

Name_____

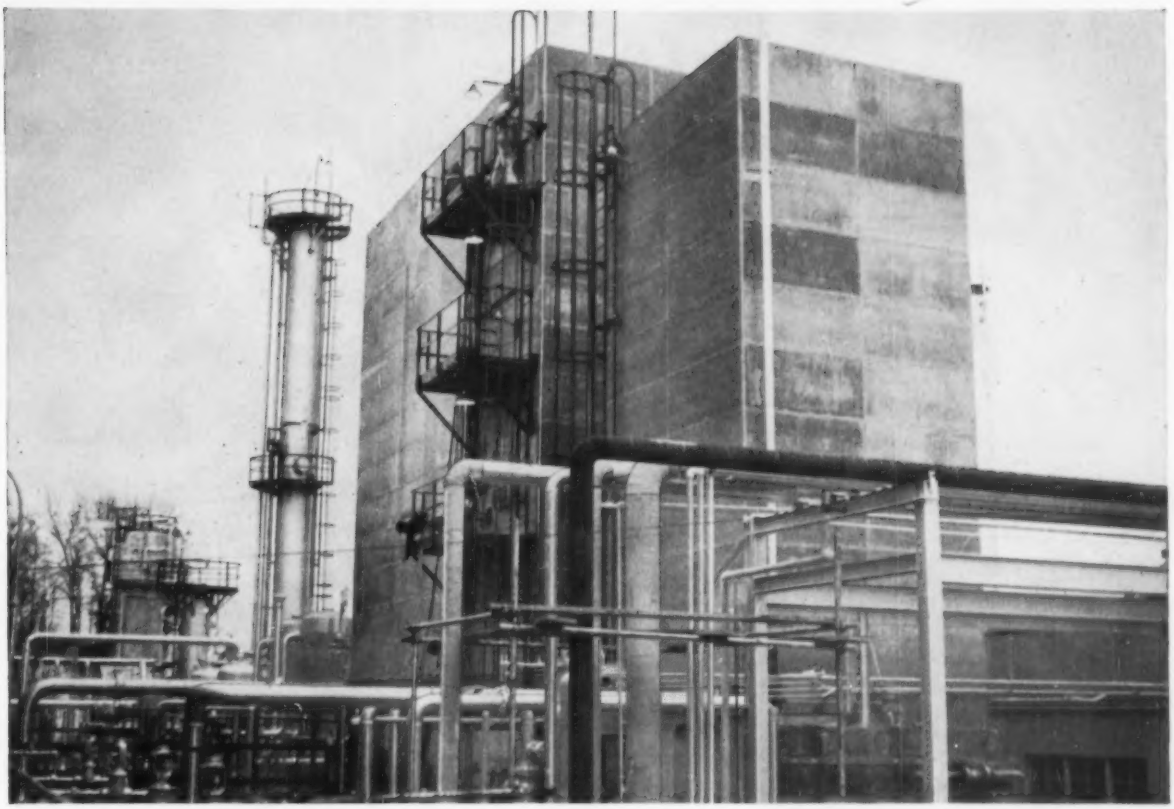
Company_____

Address_____

City_____ State_____

Petr

For more data on advertised products, use Readers' Service Cards, last page.



Tonnage Oxygen Unit and Ammonia Synthesis Gas Purification Unit, designed and built by Air Liquide for Mississippi River Chemical Company, in Selma, Missouri, and erected by Fluor Corp., Los Angeles, Cal.

DOES LOW-TEMPERATURE GAS SEPARATION FIGURE IN YOUR PROCESSING PLANS?

Why not consider the economic and other advantages of low-temperature gas separation methods in your processing program? Engineering specialists in this field are readily available to ensure sound modern design, top-quality fabrication of equipment, efficient erection and operation.

That special combination of knowledge and skills is at your service when you engage Air Liquide. Low-temperature gas separation has been our business for over half a century.

During the past fifty years AIR LIQUIDE has designed and built over 1000 hydrocarbon and air-separation plants for industries throughout the world, more than 150 of them in America. They are used to recover a variety of high-purity products, including Hydrogen, Carbon Monoxide, Methane, Ethylene, Oxygen, Nitrogen, and rare atmospheric gases.

Address your inquiries to: American Air Liquide, 529 Chrysler Building, New York 17, N. Y.

In Canada:
Air Liquide,
1111 Beaver Hall Hill,
Montreal, Que.

AMERICAN
AIR LIQUIDE
ENGINEERING & CONSTRUCTION DIVISION

OLDEST IN EXPERIENCE—NEWEST IN DESIGN

529 CHRYSLER BUILDING, NEW YORK 17, N.Y.

For more data on advertised products, use Readers' Service Cards, last page.

Warren H. Brand, Vice President in Charge of Research and Engineering, shown with members of his engineering staff working on a customer service problem.

CALL CONOFLOW for extra engineering quality

...AT A COMPETITIVE PRICE

Practical engineers insist on quality. Therefore, when it comes to final control elements, they insist on Conoflow. The engineering team at Conoflow is second to none in the field. Beyond experience and inventiveness they have an *eagerness* to serve every customer in a friendly and personal way. You get young-company vigor with big-company facilities when you turn your problems over to Conoflow.

Here, too, there are no shortcuts on materials and workmanship. "The best there is" goes into every control valve, power actuator and pneumatic regulator Conoflow turns out. You get top quality at a competitive price.

Insure yourself for quick, dependable follow-through... Invest in an *extra* measure of quality and service... call Conoflow—today!

VISIT OUR BOOTH

319-A

INSTRUMENT-AUTOMATION SHOW

Sept. 17-21 New York Coliseum and see...

NEW **ALL ELECTRIC VALVE ACTUATOR**

NEW **LTC CONTROL SYSTEM FOR PRECISE POSITIONING OF LARGE CYLINDERS**

NEW **ELECTRO-PNEUMATIC VALVE POSITIONER**

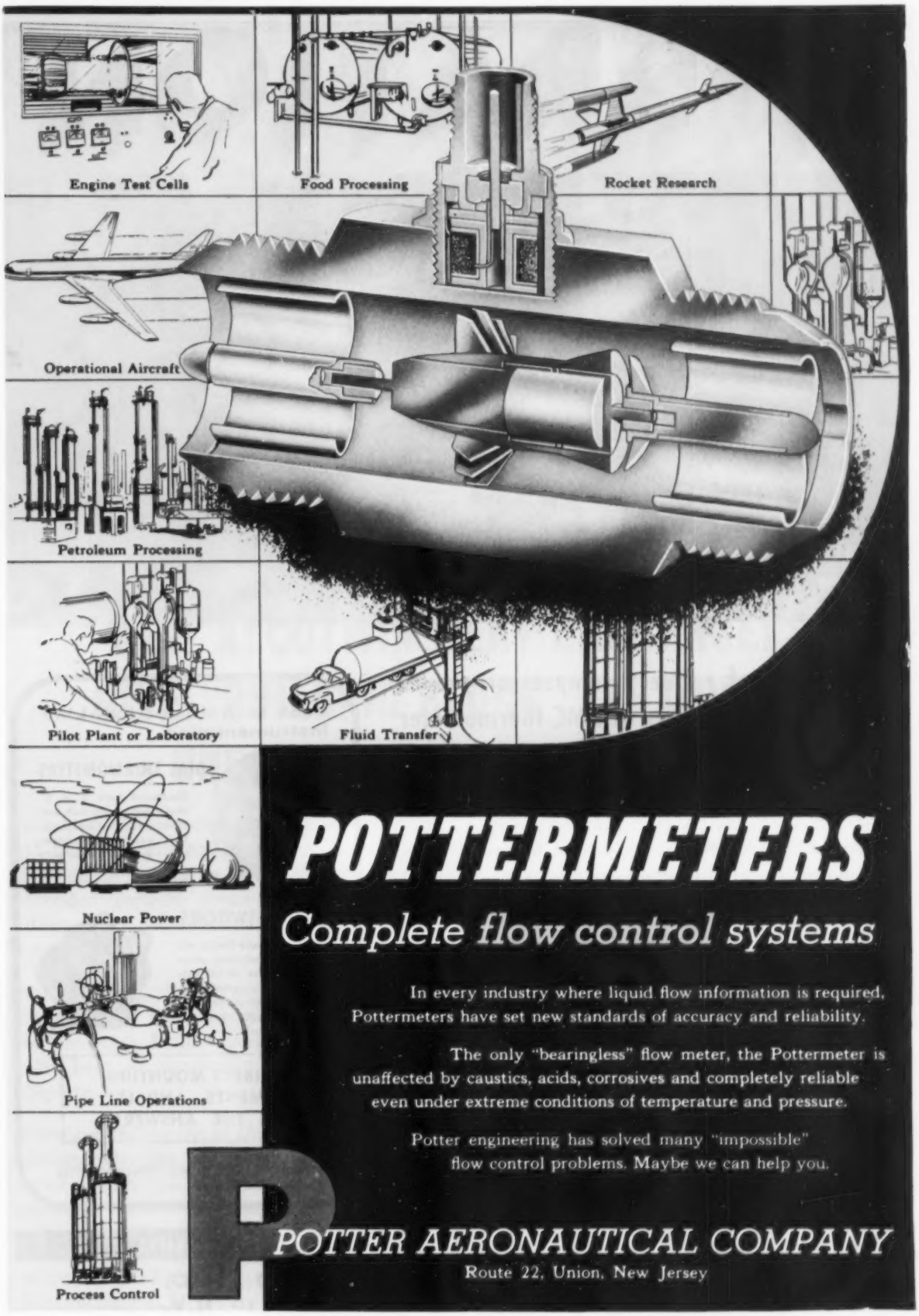
Also Regular Product Line

CC-607

Qualified Representatives in all principal cities

CONOFLOW CORPORATION | SUBSIDIARY OF WALWORTH COMPANY

2100 ARCH STREET • PHILADELPHIA 3, PA.



POTTERMETERS

Complete flow control systems

In every industry where liquid flow information is required, Pottermeters have set new standards of accuracy and reliability.

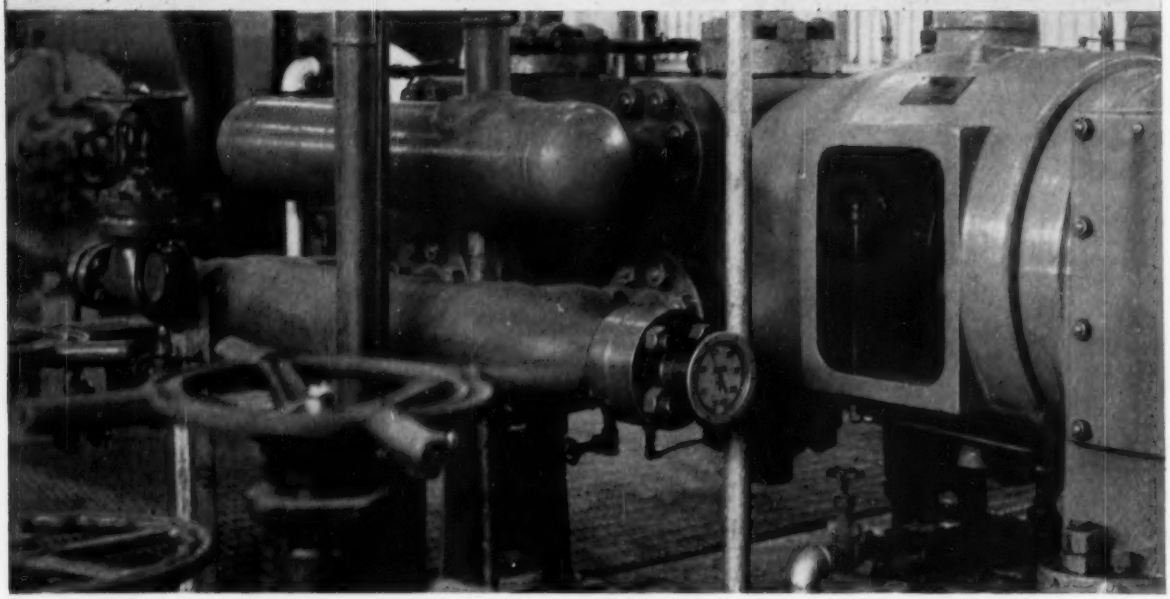
The only "bearingless" flow meter, the Pottermeter is unaffected by caustics, acids, corrosives and completely reliable even under extreme conditions of temperature and pressure.

Potter engineering has solved many "impossible" flow control problems. Maybe we can help you.

POTTER AERONAUTICAL COMPANY
Route 22, Union, New Jersey

For more data on advertised products, use Readers' Service Cards, last page.

VIBRATION



Vibration of refinery compressor proves unshakable accuracy of RMC thermometer

The RMC Thermometer shown in the photograph is constantly subjected to extreme vibration from the two-stage Synthesis Gas Compressor on which it is installed. This powerful equipment is used to compress a mixture of H_2 and N_2 from 400 to 3500 pounds—at the Philadelphia Synthetic Ammonia Plant of The Atlantic Refining Company.

This particular job required a special thermometer that could withstand the constant and terrific vibration, and at the same time provide and maintain precise, accurate readings. Rochester Manufacturing Company promptly came up with the answer—a silicone-dampened, bimetallic, angle-form RMC thermometer. And this is but one example of how RMC engineering skill provides instruments that meet the most demanding and exacting requirements.

Look to RMC for Full-Line Instrumentation

DIAL THERMOMETERS

Illustrated here is a 6" dial thermometer with hermetically sealed dial chamber, external recalibration—built for heavy duty service. What are your thermometer requirements?

PRESSURE SWITCHES

This RMC Pressure Switch will stand heavy pulsating pressures, has close on-off differentials, maintains consistent cut-in, cut-out settings. What are your pressure switch problems?

TELL US YOUR REQUIREMENTS FOR DIRECT MOUNTING AND REMOTE INDICATING INSTRUMENTS, AND LET RMC ENGINEERING SKILL PROVIDE THE ANSWERS!

REPRESENTATIVES IN ALL PRINCIPAL CITIES

RMC

"You Can Rely On Rochester"

LIQUID LEVEL, TEMPERATURE and PRESSURE INSTRUMENTS

ROCHESTER MANUFACTURING CO., INC.

38 ROCKWOOD STREET • ROCHESTER 10, N.Y.

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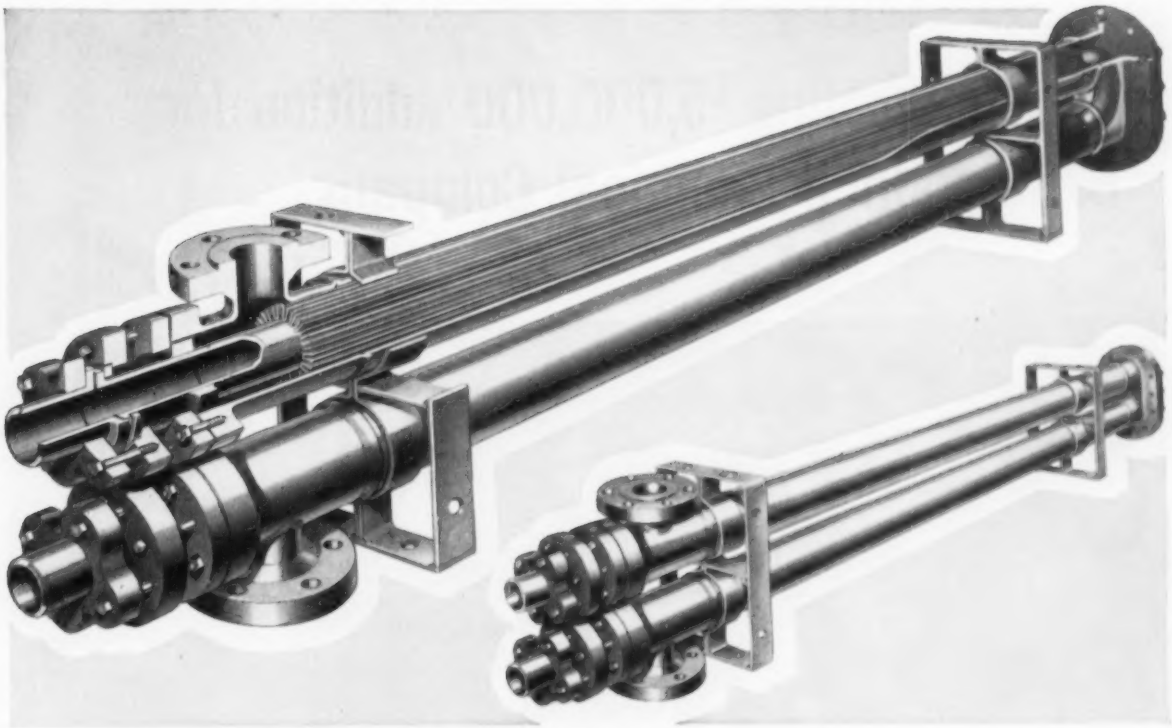


NEW ALCOTWIN HEAT EXCHANGERS GIVE "BUILDING BLOCK" FLEXIBILITY, UNEQUALLED HEAT TRANSFER

ALCOTWIN heat exchangers provide economical, high performance in package form. Their double-pipe fin tubes, with a high ratio of extended surface, make them particularly adapted to water-cooled or vapor-heated services.

Easily arranged and supplemented, ALCOTWINS readily meet changing load and process requirements. Unlike conventional shell-and-tube heat exchangers, they never become obsolete.

Standardized design of the ALCOTWIN allows custom selection of metallurgy for specific service, with the economy and availability provided by "off the shelf" standard parts.

Complete data is available from any of ALCO's sales offices. Or write P. O. Box 1065, Schenectady 1, N. Y., for brochure.

ALCO LONGITUDINAL FIN TUBES

Unequalled heat-transfer characteristics result from the fused metal-to-metal bond between the "U" shaped fin channels and the tube. ALCO's heliarc welding techniques provide a continuous, even bond resulting in higher efficiency.

ALCO

ALCO PRODUCTS, INC.

New York

Sales Offices in Principal Cities

For more data on advertised products, use Readers' Service Cards, last page.

Girdler building $5,000,000 addition for B. F. Goodrich Chemical Company

A GREATLY INCREASED flow of Geon polyvinyl chloride resins and other plastic compounds will soon be coming from B. F. Goodrich Chemical Company's plant at Avon Lake, Ohio. Girdler—who engineered and constructed existing facilities—will act as general contractor for the expanded processing plant.

The plastic resins which are produced here are the raw materials for an ever-increasing number of products ranging from plastic pipe to Army ponchos, from truck tarpaulins to circus tents.

Naturally, Girdler feels proud of being entrusted with responsibility for this expansion project. It's a good indication that our experience and ability pay off in performance. Keep this in mind when *you* plan process plant expansion or modernization and take advantage of our *complete* service and vast experience, too. Call or write for complete information.

the GIRDLER Company

A DIVISION OF NATIONAL CYLINDER GAS COMPANY

LOUISVILLE 1, KENTUCKY

GAS PROCESSES DIVISION . . . Design, Engineering, Construction of Hydrocarbon Processing Plants, Gas Producing Plants, Chemical Plants. High-grade specialty Catalysts.
Offices: New York, San Francisco

VOTATOR DIVISION . . . Continuous Processing Apparatus for liquid and viscous materials. Design, Engineering, Construction of Edible Oil Plants.
Offices: New York, Atlanta, Chicago, San Francisco

THERMEX DIVISION . . . Dielectric Heating Apparatus for materials drying, baking, curing.

For more data on advertised products, use Readers' Service Cards, last page.

to meet exacting lubrication standards, specify

ENJAY PARANOX®

detergent-inhibitor additives

When exacting lubrication standards must be met, you can depend on the Enjay Paranox group of highest-quality additives, famous around the world, for the right detergent-inhibitor to blend with every type of base stock.

Enjay has worked extensively with oil companies and leading engine manufacturers to develop lubricating oil additive formulations for military and commercial specifications.

Let us put this experience and know-how to work for *you*. Write, wire or phone the Enjay Company—your only source of a *complete* line of additives (Paramins®) for fuels and lubricants.

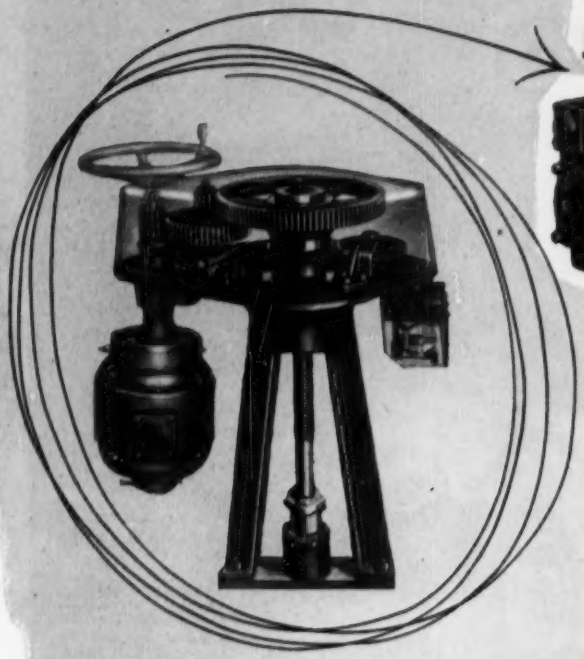
ENJAY

Pioneer in Petrochemicals

ENJAY COMPANY, INC., 15 WEST 51st STREET, NEW YORK 19, N. Y. • Other offices: Akron, Boston, Chicago, Tulsa

For more data on advertised products, use Readers' Service Cards, last page.

In the PINK of Condition



CHAPMAN MOTOR UNITS

We've done one thing for you. Chapman's Motor Units . . . for operation of valves, floorstands and sluice gates . . . are in the best of condition for accurate performance and longer, lower cost life.

We've made them as you like them . . . simplified them . . . streamlined them . . . taken off all the fat. In fact, when you look at a Chapman Motor Unit today, you can only find approximately *half as many parts* as on any other unit.

This simplicity, combined with Chapman's traditional ruggedness, means less trouble and lower maintenance over a longer period of smooth, accurate performance.

How can you go wrong? With Chapman Motor Units, the simplified design . . . the sturdy construction . . . mean no drift; less slash, accurate micrometer-controlled limit switch for predetermined seat tightness; quiet motor driven operation at all *times*. All at the lowest overall cost.

No trouble with operating positions. Operation is assured at any angle. Rugged stub-tooth gears need no grease or oil. No trouble with operating conditions. All units are weatherproof . . . *steam tight*. No trouble even with installations. When used with floorstands they are completely wired at the factory . . . ready to connect with your leads. Easy and simple to install.

Get our new catalog . . . Catalog 51 . . . on Chapman motor units today.

The Chapman Valve Manufacturing Co.
INDIAN ORCHARD, MASSACHUSETTS

WESTON

Averaging Resistance Thermometers

Just flick the selector switch to the oil depth, press the button, and instantly read the average temperature of the oil in the tank. *Time-saving* and *money saving* . . . plus on-the-button accuracy. Indicators can be mounted at the base of the tank, or at control points remote from the tank if desired. For multiple tank installations special tank selector panels are supplied. For the complete story on Weston Averaging Thermometers as well as on Weston temperature instruments to indicate, record or control, consult the Weston representative near you, or write direct to WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, N. J. A subsidiary of Daystrom, Incorporated.

THERMOMETERS *by* WESTON

For more data on advertised products, use Readers' Service Cards, last page.

Easy to Mix. Just add water according to instructions. Mixes in about five minutes.

Consistency of Mix is as workable as any cement mix.

Pours Readily into any prefabricated form.

New ALUNDUM* 33-I insulating castable...mixes and pours like concrete...protects to 3300°F.

A New Norton Refractory Rx

Now you can protect critical areas in your furnaces and other high temperature equipment to 3300°F with ALUNDUM 33-I insulating castable — a new, easy-to-install NORTON Refractory Product.

- 33-I comes in dry form in moisture-protective bags.
- 33-I — You just add water according to instructions. Mixes readily.
- 33-I pours into any prefabricated form like a concrete mix.

And . . .

- 33-I insulates up to 3300°F.
- 33-I is light in weight and monolithic in structure.
- 33-I saves down time for repairs.

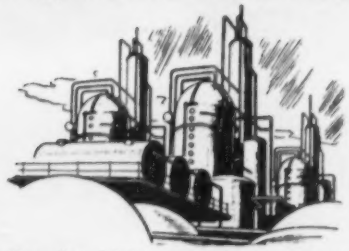
Characteristics

Density	100 lbs. per cu. ft.
Setting up time	
Stiffens	1 hr.
Initial set	4 hrs.
Final set	18-24 hrs.
Chemical Analysis — Al_2O_3	Primarily
SiO_2	< 0.1%
Fe_2O_3	< 0.1%
Maximum hot face temperature	3300°F
Water added per 100 lbs.	Approx. 2¼ gals.
Grain Size	6F

This newest Norton refractory Rx is *engineered and prescribed* for maximum protection and quick, easy installation in a wide range of uses. For further facts on ALUNDUM 33-I insulating castable, write to NORTON COMPANY, Refractories Division, 468 New Bond Street, Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto, Ontario.

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

Typical Applications in Chemical Processing



Insulation for high temperature reactors and furnaces.

NORTON

REFRACTORIES

Engineered... Rx ...Prescribed

Making better products... to make your products better

For more data on advertised products, use Readers' Service Cards, last page.

Increase efficiency . . . reduce maintenance

on your heat transfer equipment . . .

Call an EFCO engineer today

Capable EFCO mechanical engineers have the diversified experience, from hundreds of jobs designed to API-ASME or ASME Codes and TEMA specifications, to anticipate your individual heat transfer problems . . . and to design job-rated heat transfer systems that will provide *guaranteed performance* at peak operating efficiency, long life with low, trouble-free maintenance.

Job-rated EFCO installations are efficiently handling pressures to 5000 psi. Equipment for your special requirements . . . minimum low to maximum high temperature services . . . can be successfully provided.

Call an experienced EFCO engineer today and get guaranteed performance from your heat transfer equipment.

EFCO

HEAT TRANSFER EQUIPMENT

ENGINEERS &
FABRICATORS, Inc.

P. O. BOX 7395
HOUSTON 8, TEXAS

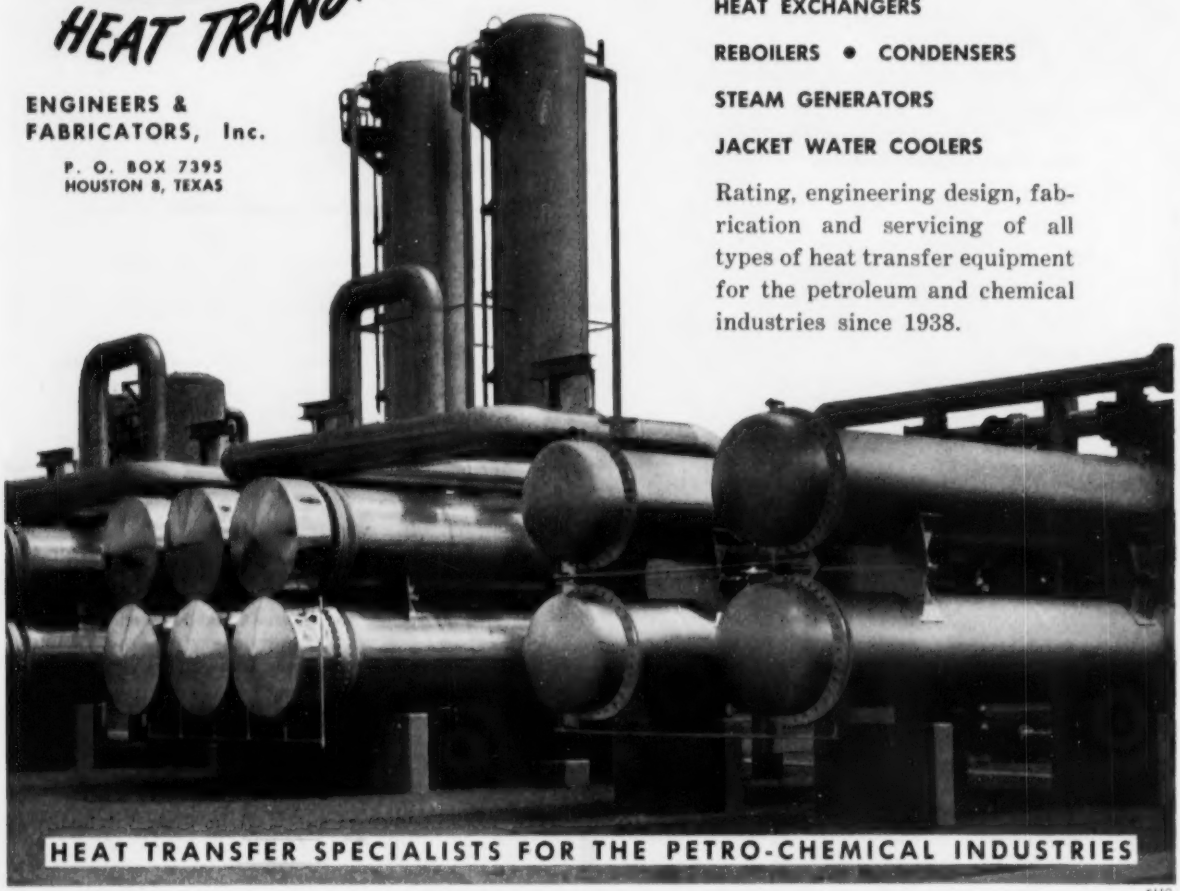
HEAT EXCHANGERS

REBOILERS • CONDENSERS

STEAM GENERATORS

JACKET WATER COOLERS

Rating, engineering design, fabrication and servicing of all types of heat transfer equipment for the petroleum and chemical industries since 1938.



HEAT TRANSFER SPECIALISTS FOR THE PETRO-CHEMICAL INDUSTRIES

6110

Economical bolting starts right here

In many bolting applications involving high temperatures and high pressures, the choice of nut can make all the difference between economical service and premature failure.

To assist refinery operators in utilizing different types of bolting, Bethlehem produces and stocks hexagonal nuts in four grades, each of which meets the requirements of ASTM specification A-194. Bethlehem nuts are top-quality nuts in every way. They are tapped to Class 2B fit, and are made in all sizes from ⅛ in. to 2 in.

Perhaps you may have a question or two about the type of Bethlehem nut which would be best to use with a Bethlehem carbon or alloy stud. If so, all you need do is write or phone the nearest Bethlehem sales office.

BETHLEHEM NUTS COME IN FOUR GRADES

Grade 1. Made of low-carbon steel, this nut is suitable for non-critical applications, as well as installations involving moderate temperatures. Carbon 0.15 min, phosphorous 0.05 max, sulphur 0.05 max. Brinell hardness is 120 min.

Grade 2. A medium-carbon steel nut, intended for use at moderate temperatures and pressures. Carbon 0.40 min, phosphorous 0.05 max, sulphur 0.05 max. Brinell hardness is 160 min.

Grade 2H. Quenched and tempered. An excellent nut for high temperature, high pressure service. Carbon 0.40 min, phosphorous 0.05 max, sulphur 0.05 max. Brinell hardness 248 to 352.

Grade 4. A heat-treated nut, made of molybdenum steel. Ideal for unusually severe conditions of temperature and pressure. Also for sub-zero work, as it has minimum Charpy impact value of 15 ft-lb down to —150 F. Carbon 0.40 to 0.50, manganese 0.50 to 0.95, phosphorous 0.04 max, sulphur 0.05 max, silicon 0.15 min, molybdenum 0.20 min. Brinell hardness 248 to 352.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

For more data on advertised products, use Readers' Service Cards, last page.

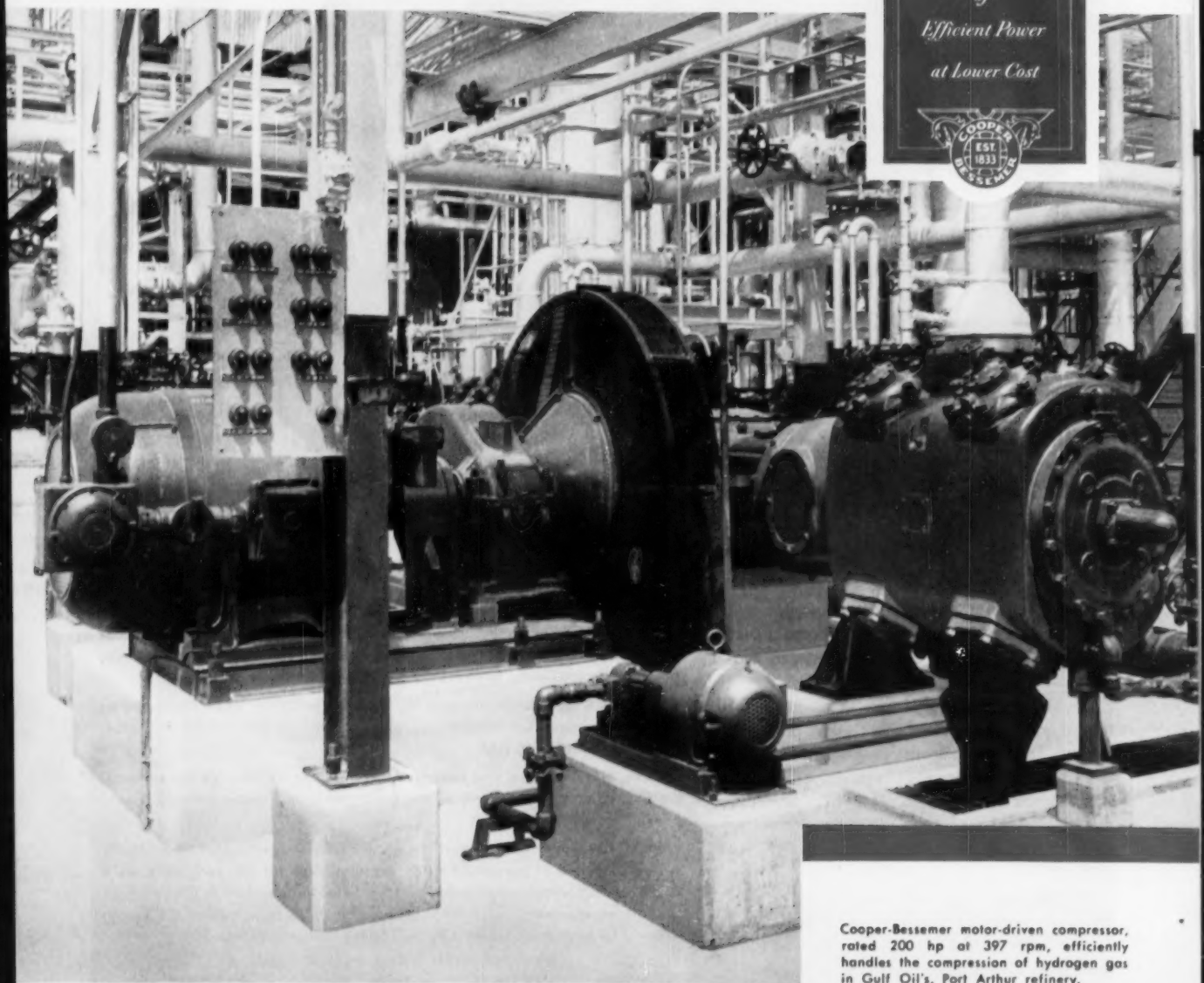
with this Cooper-Bessemer compressor....

"CLEAN HYDROGEN"

for Gulf Oil

Another Example of Efficient Power at Lower Cost

COOPER BESSEMER EST 1833



Cooper-Bessemer motor-driven compressor, rated 200 hp at 397 rpm, efficiently handles the compression of hydrogen gas in Gulf Oil's, Port Arthur refinery.

GAS • DIESEL • GAS-DIESEL ENGINES

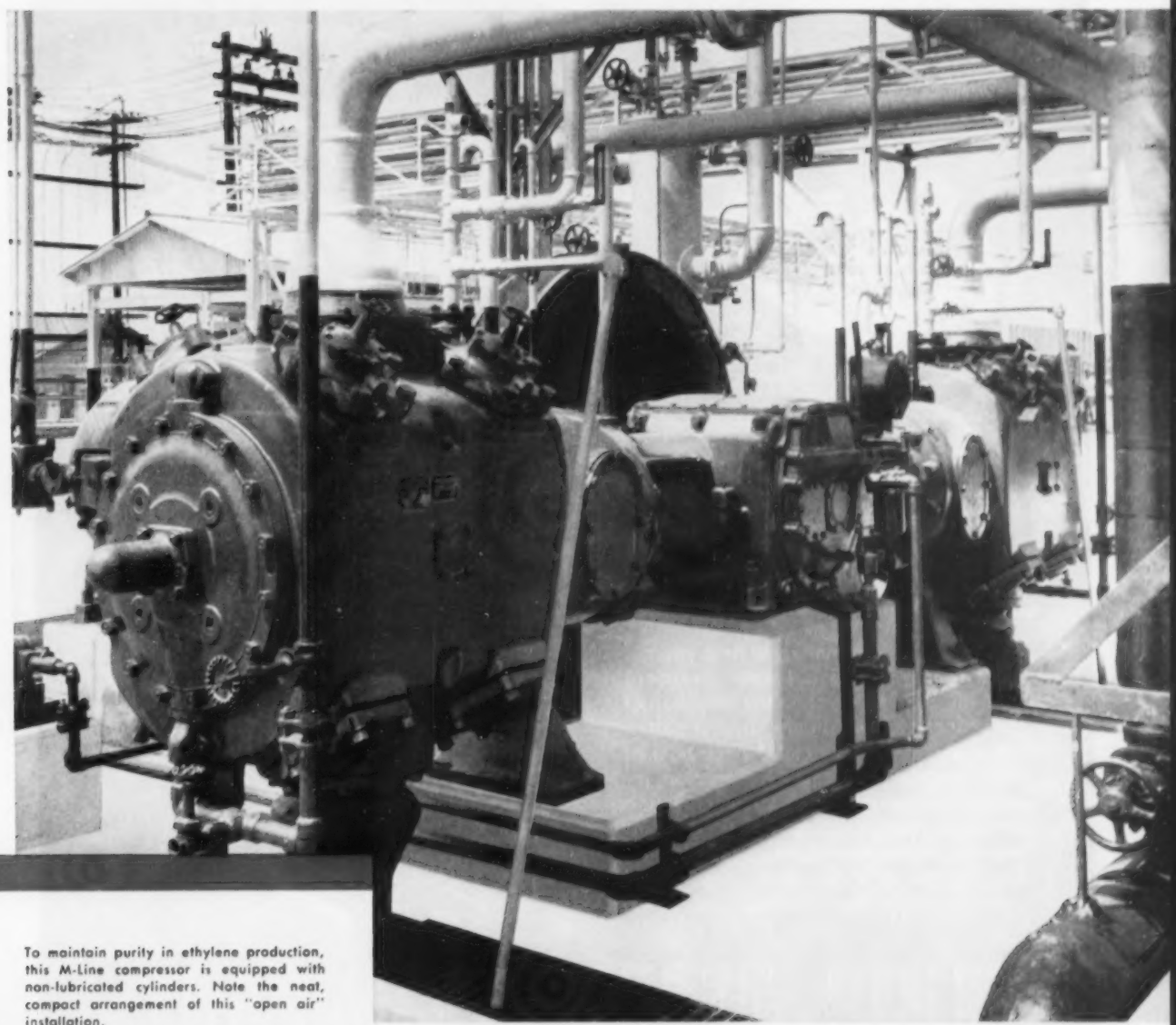
New York Washington, D. C. New Orleans

San Francisco, Cal. Houston, Dallas, Greggton, Pampa and Odessa, Texas Seattle, Wash.

• In the Port Arthur, Texas, refinery of Gulf Oil Corporation, non-lubricated cylinders in a 200 hp Cooper-Bessemer compressor prevent any trace of oil from entering the gas stream. What could be more simple . . . eliminate lubricating oil and you eliminate any possibility of contaminating the process.

These perfected cylinders offer the same trouble-free service that has long been standard when Cooper-Bessemer compressors are on the job. Operating against micro-smooth, hardened cylinder liners, 22½" diameter aluminum pistons with carbon rings require no lubrication whatever.

For high efficiency regardless of pressure or volume, for compactness, and low maintenance, Cooper-Bessemer, as usual, offers the best return on your investment dollar. Write The Cooper-Bessemer Corporation, Mount Vernon, Ohio, for additional information.



To maintain purity in ethylene production, this M-Line compressor is equipped with non-lubricated cylinders. Note the neat, compact arrangement of this "open air" installation.

by **Cooper-Bessemer**

MOUNT VERNON, OHIO AND GROVE CITY, PENNA.

Tulsa Shreveport St. Louis Los Angeles Chicago

See how straight reciprocal drive eliminates major replacement part problems.

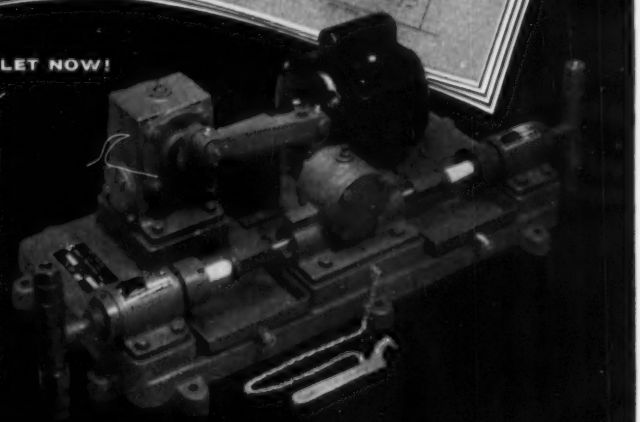
See how Hills-McCanna metering pumps can meet your exact requirements.

See how Hills-McCanna design gives you greater dependability, accuracy and longer pump life.

SEE HOW A *new heart* PUTS *new life* IN YOUR WATER TREATMENT SYSTEM!

SEND FOR THIS NEW FACT-FILLED BOOKLET NOW!

Here's useful information to help you get more from your present water treatment system . . . to help you in the selection of the proper metering pump for your particular application. This big 12-page booklet is complete with technical information, installation drawings, tables of capacities and pressures, and pump construction recommendations for metering all types of liquids. It's like having a consulting engineer at your fingertips! Write for your copy now!



HILLS-McCANNA COMPANY

2441 W. Nelson Street, Chicago 18, Illinois

METERING AND PROPORTIONING PUMPS • DIAPHRAGM VALVES
FORCE FEED LUBRICATORS • MAGNESIUM ALLOY SAND CASTINGS

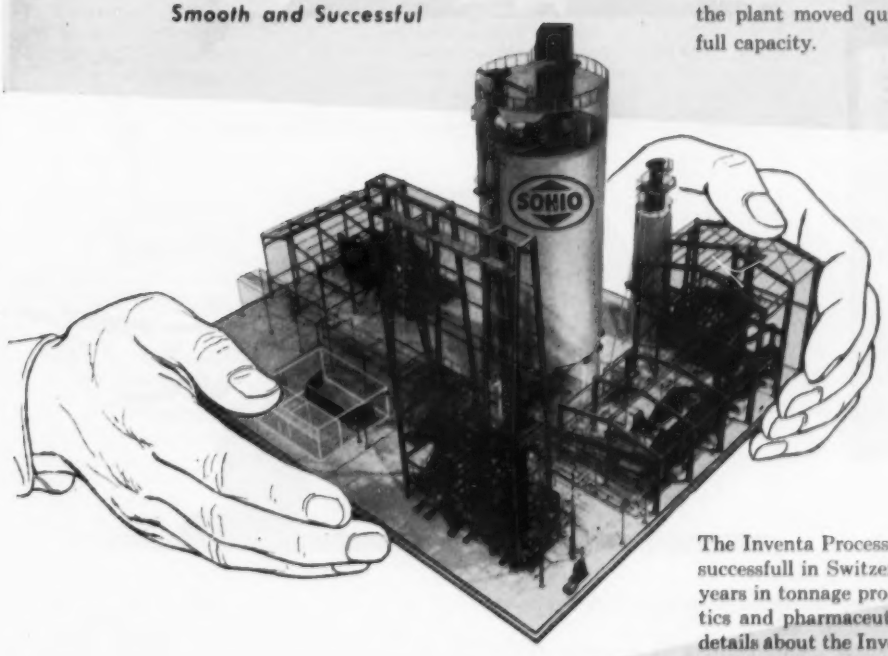
PROVEN
BY PERFORMANCE
INVENTA-VULCAN
UREA PROCESS

Sohio Startup According to Plan— Smooth and Successful

The first Inventa-Vulcan urea plant in the United States is now on stream. This new plant was designed and built by Vulcan Engineering Division—licensors of the Inventa Process in the U. S. and Canada—for Sohio's $17,000,000 petrochemicals installation at Lima, Ohio.

Within six hours after startup high quality urea was produced. Ease and reliability of operation were demonstrated. Startup produced first urea solutions and then prills for agricultural purposes exactly as planned.

Corrosion, traditionally present in urea synthesis, was conspicuously absent, as were clogged lines and contaminated product. No significant problems were encountered and the plant moved quickly and smoothly to full capacity.



VULCAN

The Inventa Process has been commercially successfull in Switzerland for more than six years in tonnage production of urea of plastics and pharmaceutical grades. Additional details about the Inventa-Vulcan Urea Process may be had by writing to the Vulcan Engineering Division.

VULCAN ENGINEERING DIVISION

VULCAN—CINCINNATI, INC., General Offices and Plant, CINCINNATI 2, OHIO
formerly The VULCAN COPPER & SUPPLY CO.

BOSTON CHARLOTTE, N. C. DENVER HOUSTON SAN FRANCISCO
VICKERS VULCAN PROCESS ENGINEERING CO., LTD., MONTREAL, CANADA

DIVISIONS OF THE VULCAN COPPER & SUPPLY CO.
VULCAN ENGINEERING DIVISION • VULCAN MANUFACTURING DIVISION • VULCAN CONSTRUCTION DIVISION

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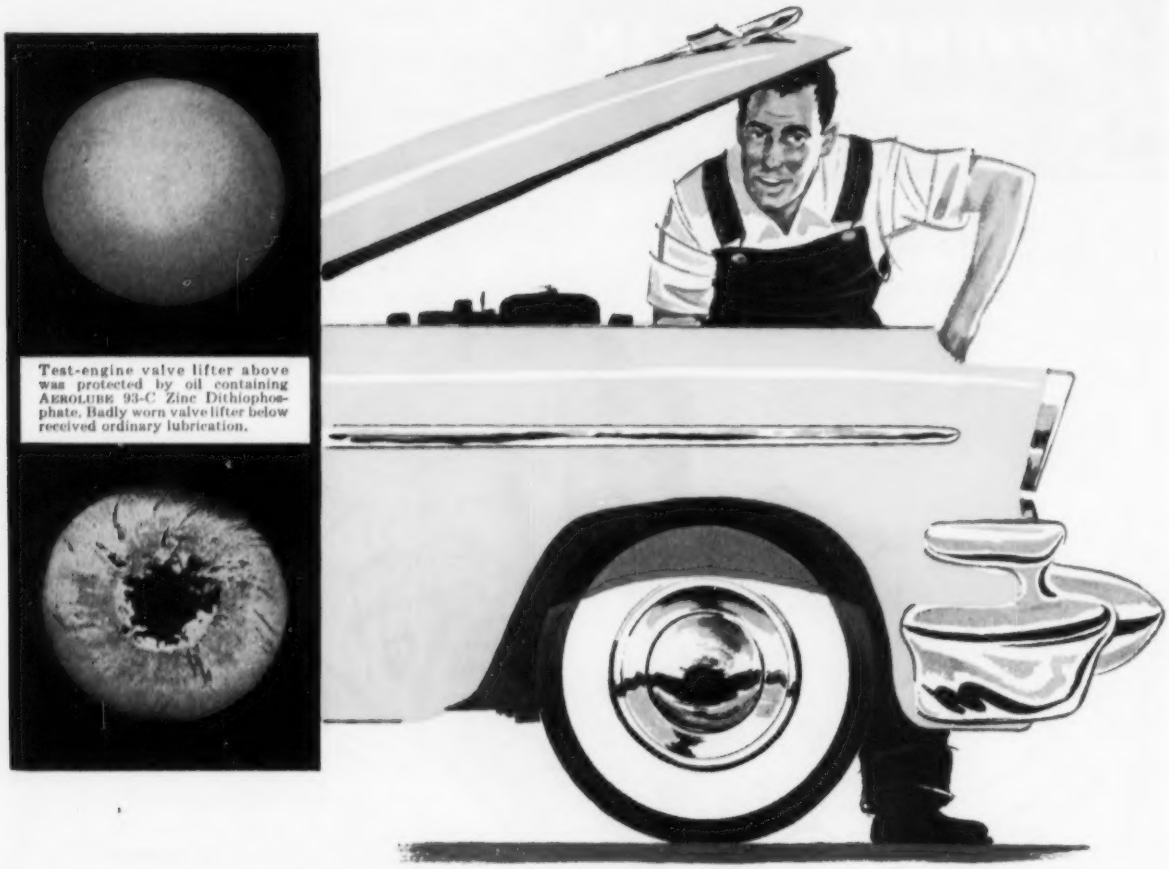
AEROLUBE® 93-C

ZINC DITHIOPHOSPHATE

Fights Wear... cuts engine repair



Test-engine valve lifter above was protected by oil containing AEROLUBE 93-C Zinc Dithiophosphate. Badly worn valve lifter below received ordinary lubrication.

Most of the new cars today are delivered with zinc dithiophosphate in the initial fill or "break-in" oil.

The reason? Major automotive manufacturers have found zinc dithiophosphate the most effective wear inhibitor, particularly in the valve train mechanisms of modern V-8 high-compression engines.

Cyanamid's AEROLUBE 93-C is a zinc dithiophosphate specially modified to give superior antiwear characteristics. It also controls oil oxidation and checks formation of oil-insoluble sludges and varnishes. It retards formation of peroxides and organic acids that corrode cadmium-silver and copper-lead bearings.

Very light in color, compatible with all lube oil stocks and other additives, AEROLUBE 93-C may be used alone for API Service MM and initial fill requirements, or with detergents such as AEROLUBE 90 for heavy-duty formulations.

Whether you are formulating lube oil for initial fill or day-to-day service, try AEROLUBE 93-C Zinc Dithiophosphate for better control of wear, oil oxidation and bearing corrosion.

CYANAMID

AMERICAN CYANAMID COMPANY
REFINERY CHEMICALS DEPARTMENT
30 Rockefeller Plaza, New York 20, N.Y.

In Canada: North American Cyanamid Limited, Toronto and Montreal

For more data on advertised products, use Readers' Service Cards, last page.

At last...the solution to

really tough

gas-cleaning problems

Sub-micron fumes are the **really tough** gas cleaning problems. These fumes cannot be economically or effectively controlled by conventional cleaning devices.

However, the Chemico P-A Venturi Scrubber is proving its success in solving these **really tough** problems in more than 150 commercial installations and in more than 70 pilot investigations.

The table lists some of these commercial installations. All of these **really tough** problems and many more are being solved with complete satisfaction to users of P-A Venturi Scrubbers.

PROCESS	DUST OR FUME	INSTALLED CAPACITY CFM
Incinerator—Flue Fed	Fly Ash	32,000
Incinerator—Sodium Disposal	Na_2O	9,000
Incinerator—Industrial	Radioactive Dust	6,000
Dry Ice & CO_2 Plants	Amine Recovery	72,400
CO_2 Gas for Process	Fly Ash	500
Boiler Flue Gas	Fly Ash & SO_2	4,300
Enamel Frit Furnace	Dust & HF	11,900
H_2SO_4 Concentrator	H_2SO_4	49,800
Copperas Roasting	H_2SO_4	34,250
Cobalt Ore Roasting	H_2SO_4	65,000
Chemico Wet Type Acid Plant	H_2SO_4	41,000
Chloro-Sulfonic Plant	H_2SO_4	600
Phosphoric Acid Plant	H_3PO_4	91,900
Phosphoric Acid Concentrator	H_3PO_4	194,000
Phosphor Copper Furnace	H_3PO_4	15,000
Smelting—Non-Ferrous		
Blast Furnace	Lead & Organic	12,000
Reverb. Furnace	Lead Compounds	23,500
Comb. Blast & Reverb.	Lead Compounds	7,000
Brass Furnace	Zinc Oxide	7,500
Ajax Furnace	Berylllium Fumes	4,000
Steel Plant		
Oxygen Steel Process	Iron Oxide	140,000
Blast Furnace	Coke & Iron Oxides	788,000
Zinc Sintering	Zinc Oxide	75,000
Wood Distillation	Tar Products	3,500
Na_2SiF_6 Dryer	SiF_4 & Dusts	700
Iron Chloride Concentrator	$FeCl_2$ & HCL Mist	40,000
Unknown	Carbon Black	1,700
Lime Kiln	Lime & Na_2O	18,000
Detergent Spray Dryer	Chemical Fume	250,000
Furfural Residue Burner	Fly Ash	36,000
Nodulizing Kiln	Manganese & Lead	25,000
Aluminum Pot Lines	Tar Fog, Fluorides	40,000
Carbide Furnace	Metal Oxides	1,000
Asphalt Plant	Rock Dust	80,000

Write to our P-A Sales Department for Bulletin M-102 describing the simple operating principle of the P-A Venturi Scrubber, and Bulletin M-103 explaining its metallurgical fume applications in the steel industry.

CHEMICAL CONSTRUCTION CORPORATION

525 WEST 43rd STREET, NEW YORK 36, N. Y.
Technical Representatives Throughout the World
Telephone LOngacre 4-9400
Cable Address: CHEMICONST, N. Y.

-- 307

For more data on advertised products, use Readers' Service Cards, last page.

Problem: Lengthen time between turnarounds... Raise production...

Solution: Ljungstrom® Air Preheater

With a Ljungstrom stills stay on stream at top capacity months longer, because preheated air mixes more thoroughly with fuel. More complete combustion greatly reduces slag forming material. You generate higher flame temperatures, increase heat-transfer rates.

That's why four of your present processing units can do the work of five. With Ljungstrom Air Preheaters each unit's output can increase as much as 25%. Example: One pipe still in an eastern refinery went from 12,000 barrels to 18/20,000 barrels after application of a Ljungstrom.

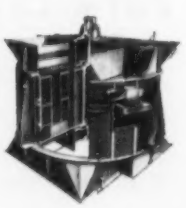
How fast is "WRITE OFF"?

Ljungstrom has many other advantages. You save up to 20% in fuel... furnace design is more economical, with no need for convection surfaces... many fuels you used to throw away can be used... through-put is consistently improved... product quality is higher. You can see, therefore, why a Ljungstrom is paid out in nine months or less.

For more complete details on what the Ljungstrom Air Preheater can do for you – for an analysis of the heat recovery benefits attainable in fuel burning equipment – call or write The Air Preheater Corporation.

Wherever You Burn Fuel, You Need Ljungstrom

The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transferred from the waste gases to the incoming cold air.



The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

How to simplify control problems

Keep systems flexible, carry small inventory, cut maintenance cost with the **Bailey Building Block Method** of instrumentation and control.

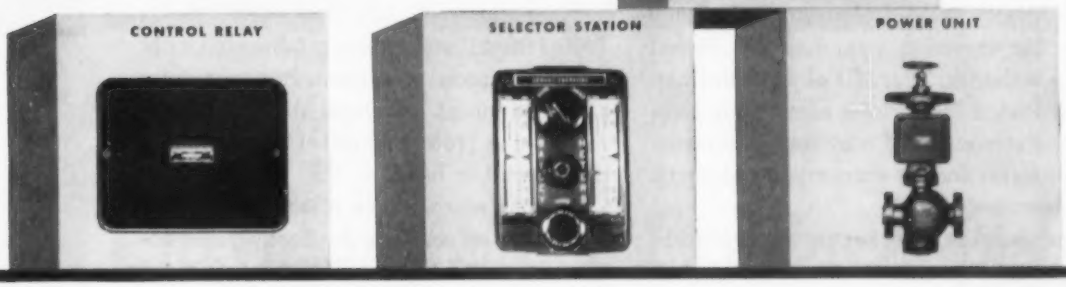
What is the Bailey Building Block Method? It's using standardized Bailey measuring, transmitting, and controlling components and combining them into any system you need. Components can be added as needed . . . removed and reused elsewhere . . . recombined into another system when the need changes. It's flexibility plus!

It's all based on the simple fact that a Bailey instrument or control component doesn't care if the measured variable is steam flow, tank level, or tower temperature, to pick just three examples. System components—transmitters, receivers, relays, selector stations, power units—are standardized for multi-purpose use.

A spare component can be used in any one of many systems. Gone are delays waiting for shipments of special parts. Gone are large inventories of spares and parts. Simplified is the training of men for maintenance.

There are many exclusive features and advantages of the individual components used in the Bailey Building Block Method. And there's much more to the Building Block story itself.

For further details, call our local district office or write us at Cleveland. Our engineers will be glad to prove how the Building Block approach will save you money and simplify your instrument and control problems.



G36-1

BAILEY BUILDING BLOCK METHOD

BAILEY METER COMPANY
1043 IVANHOE ROAD, CLEVELAND 10, OHIO
In Canada—Bailey Meter Company Limited, Montreal

RESULTS IN: FLEXIBILITY, SIMPLICITY, ECONOMY

BAILEY METERS

For more data on advertised products, use Readers' Service Cards, last page.

do you want low-cost corrosion or contamination

Acetone • Butyl Acetate • Calcium Carbide • Calcium Carbonate • Calcium Chloride (Flake) • Ethyl Acetate • Ethyl Alcohol • Ethylene Glycol • Glycerine • Insecticide Concentrates • Soap and Soap Lye • Soda Ash • Sodium Bicarbonate • Sodium Silicate •

CF&I

LECTRO-CLAD*

Trademark

Nickel Plated Steel Plates will give it to you

Yes, you can get low-cost, yet effective protection against contamination and corrosion with all these chemicals...and many more!

Effective in heavy industrial applications where the corrosion rate does not exceed 0.0015 inches per year, CF&I LECTRO-CLAD Nickel Plated Steel Plates successfully combine the corrosion and contamination resistance of nickel and the economy and strength of carbon steel.

That's because CF&I LECTRO-CLAD is made by the Bart Process, which consists of electrodepositing a heavy layer of 99% pure nickel on a carbon steel plate. This process results in a permanent bond between the nickel and the steel base. The nickel plating is customarily supplied in the 8-10 mil range; however, it can be plated up to 15-20 mils, if specified.

What's more, CF&I LECTRO-CLAD Nickel Plated Steel Plates are easily fabricated without costly special equipment. Just use regular shop equipment and bend it... weld it... roll it—the protective nickel layer will not check, spall or flake!

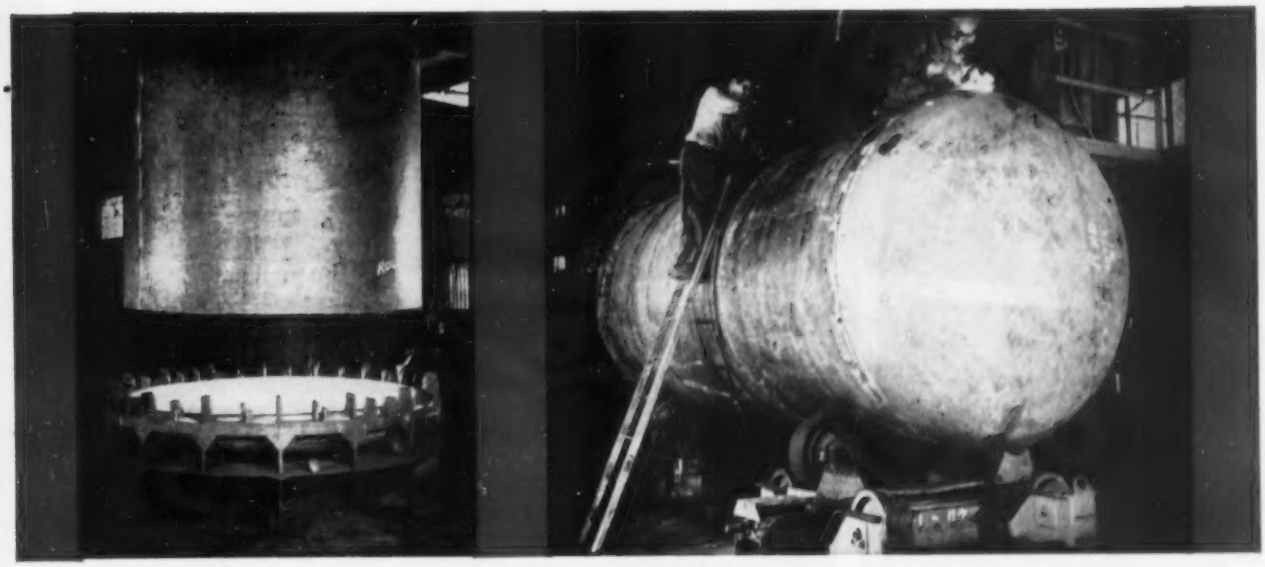
Ask our nearest sales office for the complete story on economical, effective, easy-to-fabricate CF&I LECTRO-CLAD Nickel Plated Steel Plate today. Wickwire Spencer Steel Division, The Colorado Fuel and Iron Corporation, P. O. Box 1951, Wilmington, Delaware.

***NICKEL PLATED BY THE BART LECTRO-CLAD PROCESS**

For more data on advertised products, use Readers' Service Cards, last page.

protection against with these chemicals?

Caustic Soda • Chlorinated Hydrocarbons • Cold Hydrofluoric Acid • Dibutyl Phthalate
Methyl Alcohol • Petroleum Catalysts • Phenol • Potash • Resin Plasticizers • Salt
Sodium Sulphate • Titanium Dioxide • Tricresyl Phosphate



Assembling a tank fabricated from CF&I LECTRO-CLAD Nickel Plated Steel Plates.

3798

Claymont Steel Products

CF&I

Products of Wickwire Spencer Steel Division • The Colorado Fuel and Iron Corporation

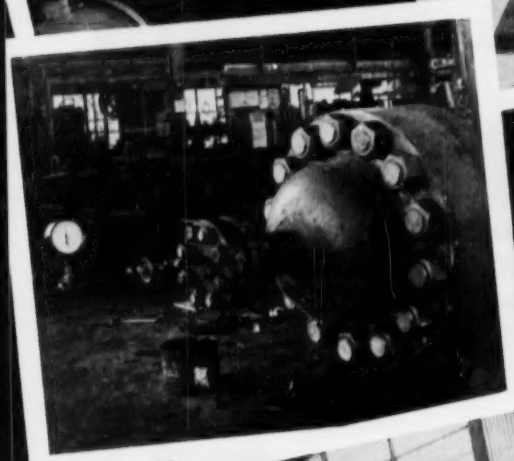
Albuquerque • Amarillo • Atlanta • Billings • Boise • Boston • Buffalo • Butte • Casper • Chicago • Denver • Detroit • El Paso • Ft. Worth • Houston • Lincoln (Neb.) • Los Angeles
New Orleans • New York • Oakland • Odessa • Oklahoma City • Philadelphia • Phoenix • Portland • Pueblo • Salt Lake City • San Francisco • Seattle • Spokane • Tulsa • Wichita
CF&I OFFICE IN CANADA: Toronto CANADIAN REPRESENTATIVES AT: Edmonton • Calgary • Vancouver • Winnipeg

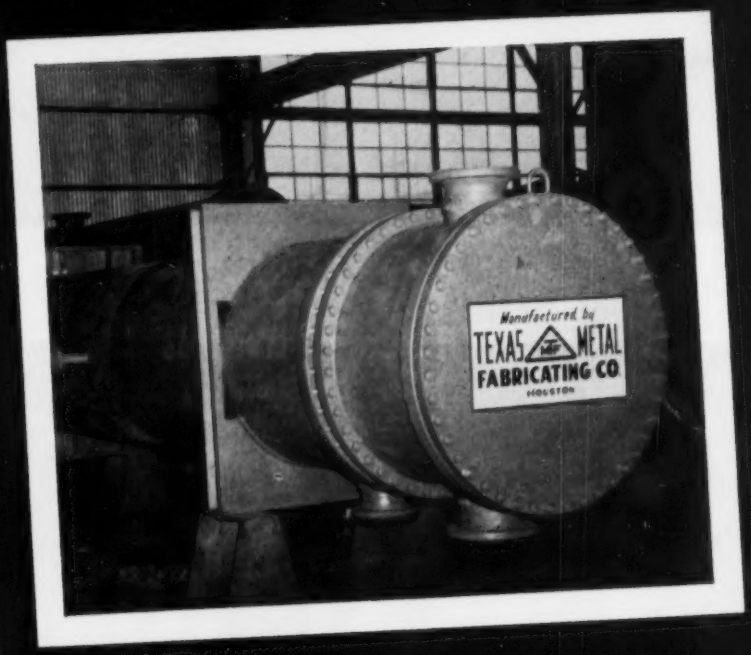
OTHER CLAYMONT PRODUCTS

Stainless-Clad Plates • Manhole Fittings and Covers • Large Diameter Welded Steel Pipe • Fabricated Steel Parts • Flanged and Dished Heads • Alloy Steel Plates • High Strength Low Alloy Steel Plates

HEAT EXCHANGERS

FOR THE PETROLEUM, CHEMICAL, AND PROCESS INDUSTRIES





DESIGN • REPAIR • FABRICATION

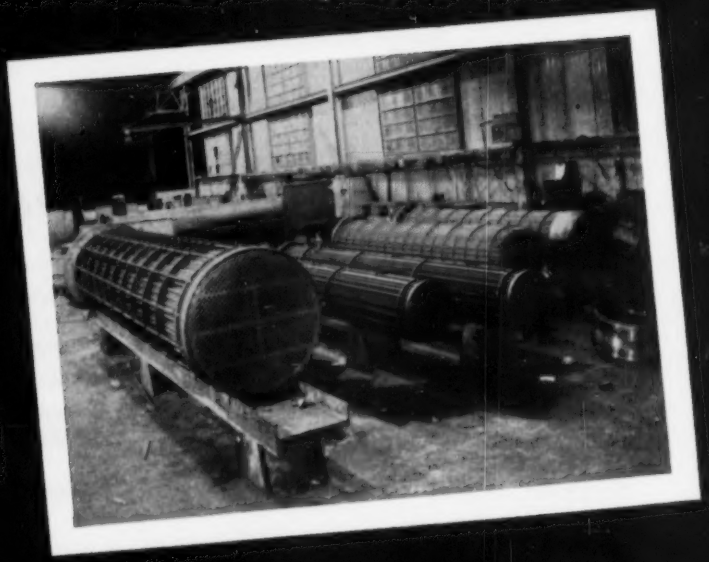
Your inquiries are cordially invited.

MTF

TEXAS METAL FABRICATING CO.

BOX 7567 - HOUSTON 7, TEXAS

API-ASME AND ASME CODE CONSTRUCTION



ONE MAN can operate this giant orifice fitting!

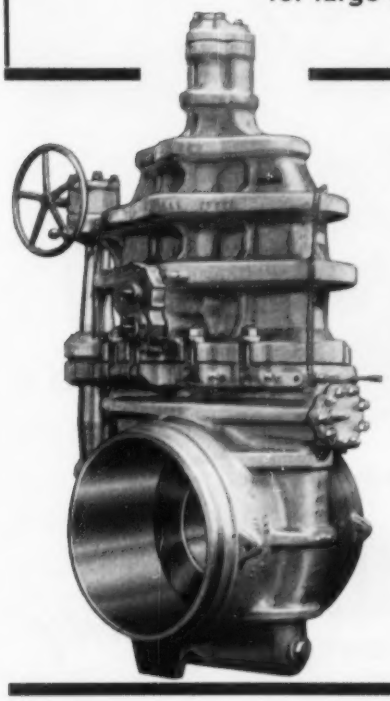
Over eight feet high and weighing five tons, this 30″, 600 lb. ASA Commercial Type CS Orifice Fitting can nevertheless be operated easily and safely by one man.

The 4600-lb. upper chamber swings out smoothly by turning the handwheel. No ladders or platforms are required, as the crank-operated orifice plate carrier is lowered within easy reach of the operator.

This giant fitting will be installed in a transmission line for delivery of gas from Texas and New Mexico to California. At 1440 psi line pressure, it is capable of metering 1¼ billion cubic feet of gas per day at maximum capacity —a volume great enough to supply 3 million homes, or a population of 8¾ million people. This is more than the average daily requirement of all the people and industry in Los Angeles City and County combined.

COMMERCIAL type CS orifice fitting...

for large-diameter gas and oil transmission lines



For controlled metering on oil and gas production, transmission and gathering lines, there is a Commercial Orifice Fitting for every application.

TYPE CN—Chambered, Bonnet Type, available in sizes 2″ to 20″, 125 to 2500 lb. ASA.

TYPE CS—Chambered, Swinging Type, is available in sizes 24″ and larger, 125 to 600 lb. ASA.

DEADLINE FITTINGS include Type DSB, with stud-bolted covers, sizes 2″ to 24″, 125 to 600 lb. ASA; Type DPL, with Pin-Locked cover, sizes 2″ to 24″, 600 to 2500 lb. ASA; and Type D-600, with stud-bolted cover in sizes 2″ to 6″, up to 600 lb. ASA.

For detailed information on Commercial Orifice Fittings and list of distributors, see your Refinery or Composite Catalog, or write:

COMMERCIAL IRON WORKS

2424 Porter Street
LOS ANGELES 21, CALIFORNIA

For more data on advertised products, use Readers' Service Cards, last page.

We've written a NEW RECORD...

Our printer has just delivered to us a brochure which gives a little of the history of our Company and is liberally illustrated with pictures of completed projects. If you are part of the management team in the refinery, chemical plant, ore processing, secondary recovery or gas processing industry, we believe you will be interested in seeing this.

Just have your secretary drop us a line on your company letterhead and a copy will be forwarded to you promptly.

TRECO

A DIVISION of VITRO CORPORATION of AMERICA

The REFINERY ENGINEERING Company

NEW YORK TULSA TORONTO

You and I both belong here! After all, there wouldn't *be* any busy highways without us! I'm a secretary to a land man. You may be anything from a driller to a board chairman. Between us we helped keep over 50 million cars on the road last year. People used them for fun, convenience, business. Remember that, the next time you hear unfair criticism of us oilmen. We've got lots of facts on our side. Let's speak up and make the facts known! **SHELL OIL COMPANY**

For more data on advertised products, use Readers' Service Cards, last page.

LADISH

SEAMLESS

Multiple Outlet

FITTINGS

TO MARK PROGRESS

Typical fittings and piping layout of coils in a charge heater.

LADISH DESIGNED 90° AND 45° ELBOWS

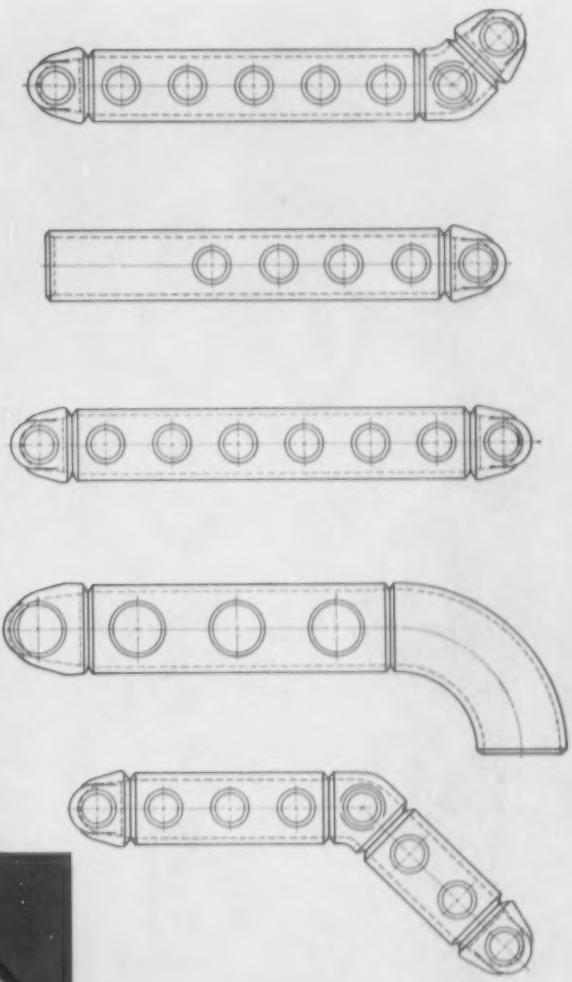
PATENT PENDING

Special die-forged Ladish 90° Reducing Heater Elbow provides a lower cost, easier to make up, final outlet and end closure. Obsoletes expensive, heavy-volume fillet weld required on straight blank-off design. Pressure drop is minimized and flow efficiency improved. Residue collecting pockets and stress risers at critical locations are eliminated. Provides ample clearance between fittings for ease of installation and more expansion allowance.

Ladish forged 45° Side Outlet Elbow effects positive savings in time and cost over the undesirable miter joint otherwise necessary. Eliminates time-consuming angle cutting and welding —then scribing, torching and nozzling-in of outlet directly over miter joint. Only two, easy-to-make circumferential butt welds required . . . deposition of weld metal at this critical juncture is minimized.

IMPROVE FLOW EFFICIENCY ... SAVE PIPING ERECTION COST IN HEATER INSTALLATIONS

Illustrated here are typical combinations of Ladish Multiple Outlet Fittings, 90° Reducing Heater Elbows and 45° Side Outlet Elbows produced to meet design requirements for heaters with varying flow cycles.

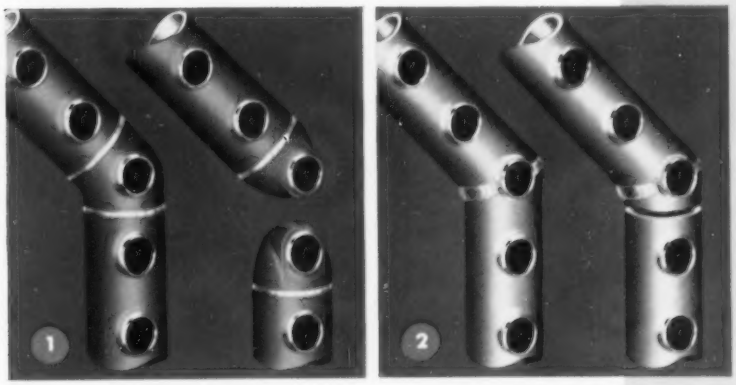


SEAMLESS Multiple Outlet Fittings developed and produced by Ladish . . . offer you significant design advantages and installation and operational economies.

Only simple circumferential welds are required to join the integral outlets to heater tubes. Expensive nozzling-in and reinforcing operations are eliminated.

Ladish 90° Reducing Heater-Elbows and 45° Side Outlet Elbows used in combination with Ladish Seamless Multiple Outlet Fittings further cut installation costs . . . improve both design and flow efficiency.

These fittings are manufactured in a wide range of sizes and material specifications to the same rigid metallurgical and manufacturing standards which distinguish Ladish Controlled Quality Fittings.



1 Ladish streamline design simplifies installation, improves flow efficiency and assures ample expansion allowance between coil sections.

2 Obsolete miter joint construction leaves insufficient space between coil sections, complicates installation, restricts expansion.

THE COMPLETE *Controlled Quality* FITTINGS LINE

LADISH CO.

CUDAHY, WISCONSIN
MILWAUKEE SUBURB

District Offices: New York • Buffalo • Pittsburgh • Philadelphia • Cleveland • Chicago • St. Paul • St. Louis • Atlanta • Houston • Odessa • Tulsa • Denver • Los Angeles • San Francisco • Seattle • Havana • Mexico City • Brantford, Ont.

LADISH CO.
Cudahy, Wisconsin

We're interested . . . have Ladish representative call to discuss our application.

Name _____ Title _____

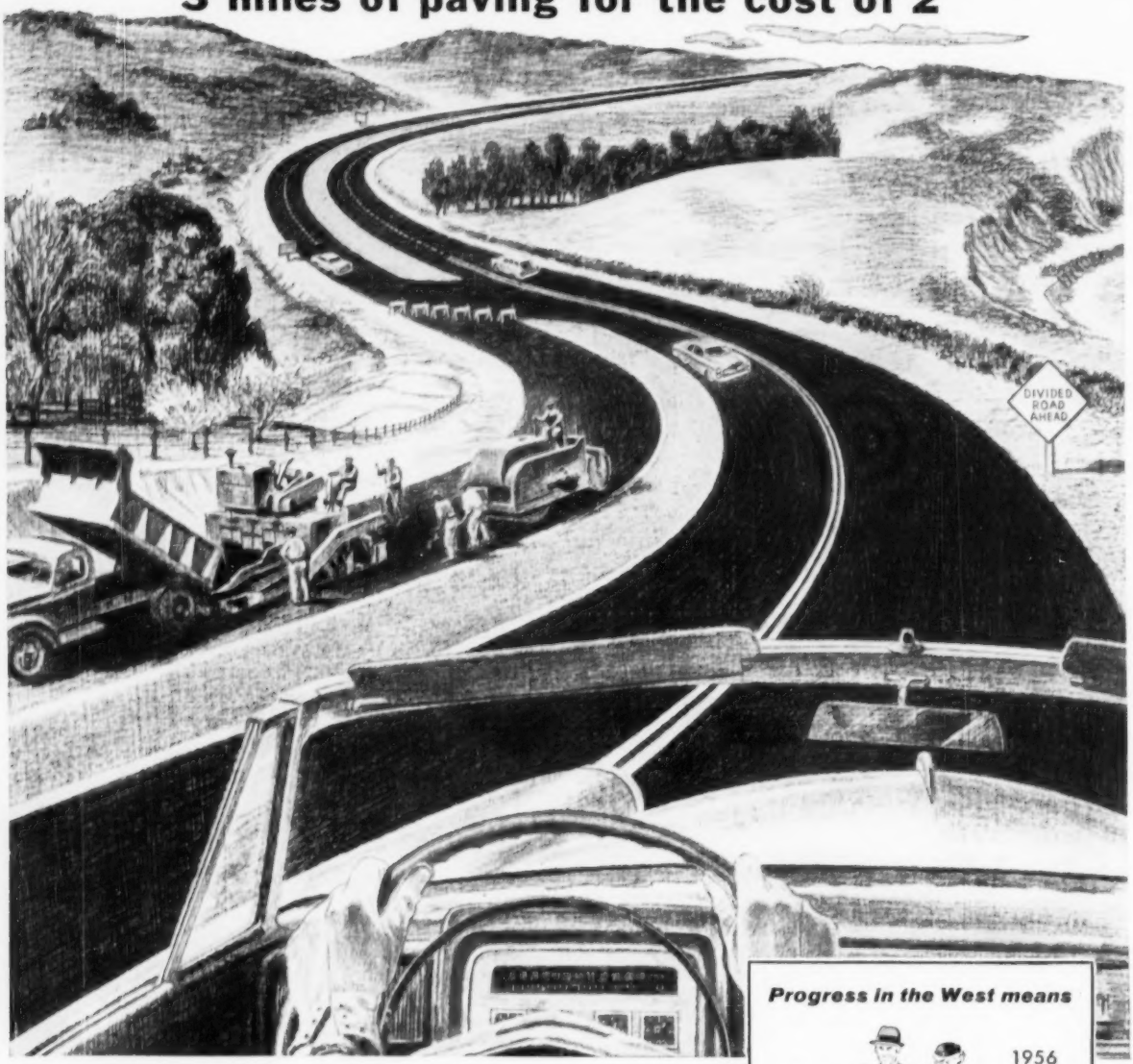
Company _____

Street _____

City _____ State _____

PR

Standard asphalt research helps bring taxpayers 3 miles of paving for the cost of 2



You are more comfortable, get there faster, when you drive on safe, modern roads of sturdy and resilient asphalt.

CROWDED HIGHWAYS waste motorists' time—and lives. To build more miles of better roads at lowest cost, highway engineers turned to asphalt paving for 85% of the nation's roads. They find asphalt costs 30 to 50% less than other pavements. It lasts longer, reduces headlight and sunlight glare, provides noiseless, comfortable driving. To help meet the nation's highway needs, Standard* has expanded its asphalt production across the country, now operates nine asphalt refineries.

Our scientists work with highway engineers on improved construction techniques which save millions of your tax dollars each year. This means more and better roads, to serve a nation on the move.

Progress in the West means

20,000 miles of additional highway construction by 1965

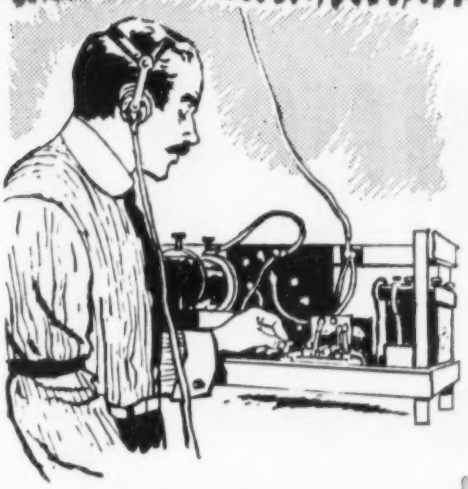
**through Standard's wholly-owned subsidiary, American Bitumuls & Asphalt Company*

STANDARD OIL COMPANY OF CALIFORNIA

puts petroleum progress to work for you

For more data on advertised products, use Readers' Service Cards, last page.

75 years ago and 14 years before the first Practical Wireless was invented



Koven was making individualized petroleum equipment

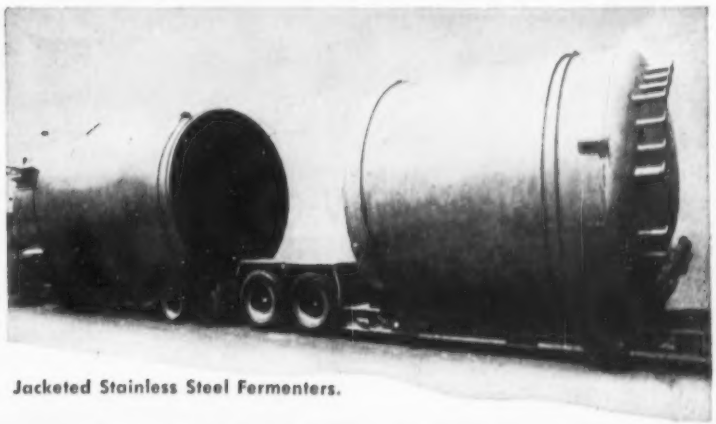
There's no substitute for experience — the time and the skill it takes to manufacture individualized petroleum equipment which saves trouble and expense for petroleum refiners.

For 75 years KOVEN has produced just this kind of equipment—efficient, low-cost equipment fabricated to exact specifications — thereby helping countless processors to achieve fast, economical production.

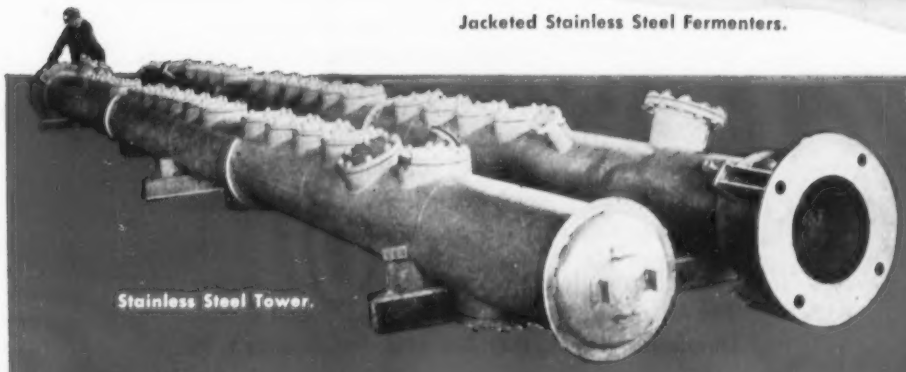
KOVEN asks you to investigate. You can do it by simply sending for Bulletin #550, and either calling or writing for a consultation with a trained representative. Do it today. There's no obligation.

X-RAY INSPECTION FOR QUALITY CONTROL

KOVEN equipment in all metals and alloys includes: High pressure vessels built to A.S.M.E., A.P.I. Codes; extractors; mixers; stills; kettles; tanks; stacks; breechings; hot transfer lines; light and heavy fabricated piping and plate exhaust ducts. Shop and field erected storage tanks to 2 million gallons. High vacuum testing on liquid oxygen storage tanks.



Jacketed Stainless Steel Fermenters.



Stainless Steel Tower.

SPECIALISTS IN INTRICATE FABRICATION USING:

- STAINLESS STEEL
- ALUMINUM
- MONEL
- NICKEL
- INCONEL
- ALL CLAD MATERIALS

Fabrication to all A.S.M.E. Codes

Koven FOR INDIVIDUALIZED EQUIPMENT SINCE 1881

L. O. KOVEN & BRO., INC. • 154-P OGDEN AVE., JERSEY CITY 7, N. J.

PLANTS: JERSEY CITY, N. J. • DOVER, N. J. • TRENTON, N. J.

For more data on advertised products, use Readers' Service Cards, last page.

...your low-cost key to high octane

Atlantic's Catalytic Reforming Process continues to prove its ability in giving superior results on a broad variety of feed stocks. Catforming's simplicity brings savings through increased efficiency every step of the way—actually eliminating many profit-robbing intermediate steps.

Regardless of the volume of your charge stock, Catforming deserves your attention. One major reason that Catforming has "proved out" commercially is attributable to Atlantic's broad experience in all phases of petroleum refining and processing.

We invite your inquiries on Catforming. Write or wire The Atlantic Refining Company, Research and Development Dept., P.O. Box 8138, Philadelphia 1, Pa.

ATLANTIC

it's the CATALYST that counts

For more data on advertised products, use Readers' Service Cards, last page.

One of the lessons not to be found in books but learned in the "University of Hard Knocks" is that critical piping can be an expensive headache to any power or processing plant but for the specialized experience of experts. On your next high-temperature, high-pressure job, ask us in.

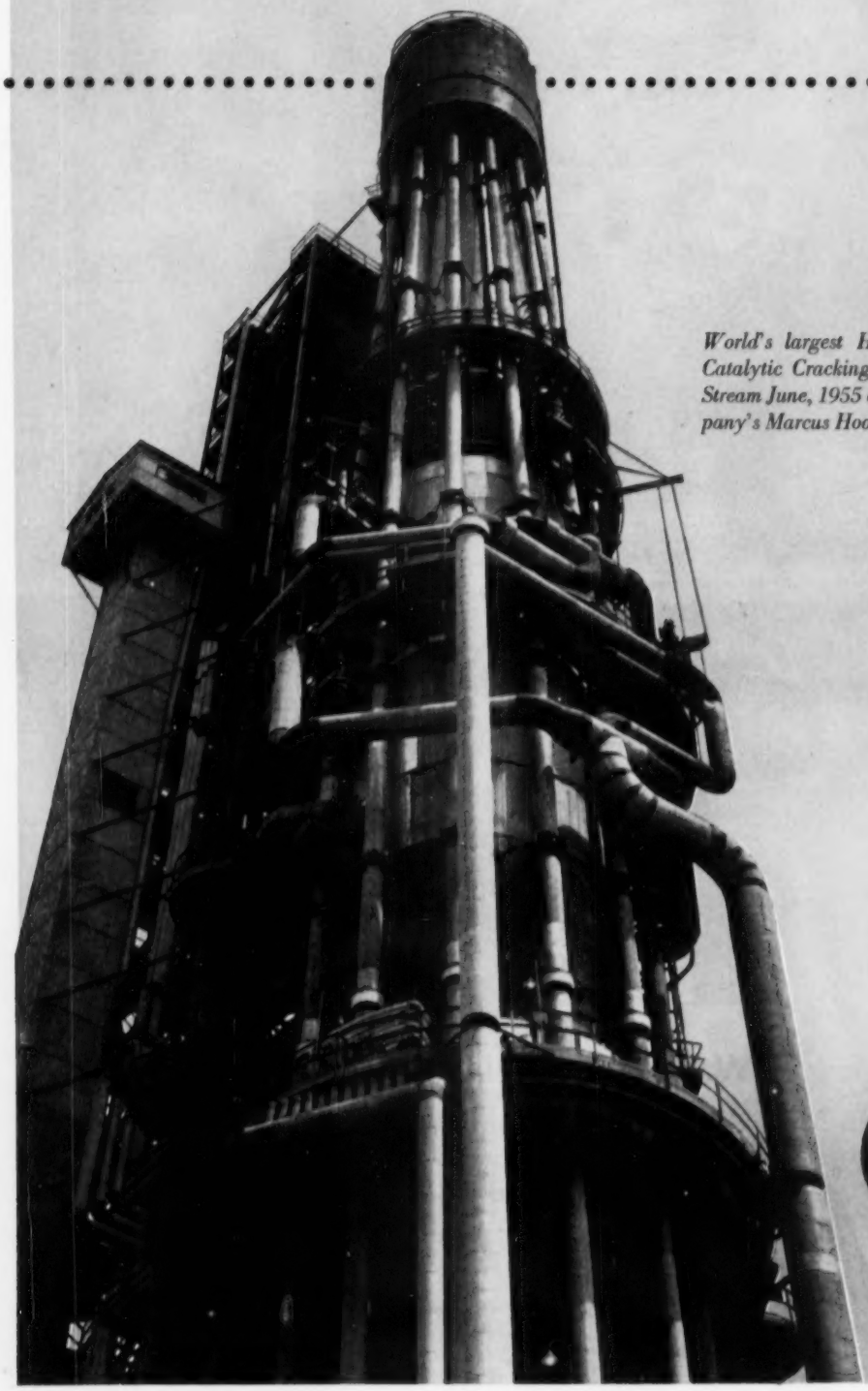
WESTPORT JOINT
(PATENTED)

W. K. MITCHELL & CO., INC.
Philadelphia 46, Pa.

MITCHELL PIPING
SINCE 1899

PIPING FABRICATORS AND CONTRACTORS

Discover for yourself...the inherent



World's largest HOUDRIFLOW Catalytic Cracking Unit Went on Stream June, 1955 at Sun Oil Company's Marcus Hook, Pa. Refinery.

For more data on advertised products, use Readers' Service Cards, last page.

economies of Houdry Processes

20 YEARS AGO—after 13 years of fundamental research—Houdry Process Corporation pioneered the first commercially practicable catalytic cracking unit, as well as the first natural and synthetic cracking catalysts. This resulted in important and far-reaching changes in the petroleum processing industry. Since that time, through continuous research and extensive commercial experience, Houdry has developed other processes and catalysts that offer refiners many inherent economies and better products.

Research, Engineering and Technical Services

Houdry scientists carry on a continuous program of research related to catalysis, processing and equipment. Houdry engineers assist refiners in the planning, operating, maintenance and profitable exploitation of their processing facilities. Subsequent service to licensees may include continuing plant surveys, application of design studies, direct assistance with operating problems and studies of changes in processing schemes required to meet changing crudes and products.

Catalyst Manufacturing and Marketing

The Chemicals Division of Houdry manufactures synthetic silica-alumina catalysts and a line of extremely hard alumina base catalysts, plus other special types. In 1956, a new pelleted kaolin cracking catalyst was introduced for marketing. Houdry's long experience in catalysis permits integration of catalyst performance with specific application requirements. The Chemicals Division also produces pelleted type catalysts to specification, and develops catalysts for special needs.

HOUDRIFLOW Catalytic Cracking Process for the highest product yields at lowest costs

The HOUDRIFLOW Process is outstanding for its high yields of gasoline and high liquid recoveries with accompanying low coke and low dry gas yields. HOUDRIFLOW's simplified design affords flexibility in the choice of operating conditions and types of charging stocks to be processed. The integration of the reactor and kiln into a single vessel makes it necessary to lift the catalyst only once and requires a smaller ground area for the installation of a unit of a given capacity.

HOUDRESID Catalytic Cracking Process for catalytically cracking the bottom of the petroleum barrel

The HOUDRESID Process eliminates the production of heavy residual fuel by making it practical and economical to catalytically crack the bottom of the petroleum barrel. This refinery-proved, continuous moving bed process converts reduced crudes into exceptional yields of high-octane gasoline and light distillate fuel. The process is well adapted to the use of synthetic or natural clay catalyst, and to the charging of a wide range of reduced crudes.

HOUDRIFORMING Catalytic Reforming Process for maximum yields of aromatics or highest octane fuel

The HOUDRIFORMING Process assures maximum yields of high octane fuel and aromatic concentrates from straight-run naphthas. By utilizing a dual-function catalyst, HOUDRIFORMING provides complete flexibility for producing aromatics or motor gasoline. The process is continuous and non-regenerative. However, for flexibility of operation the catalyst can be regenerated *in place.*

HOUDRY ISO-PLUS Catalytic Reforming Process for reforming low-octane naphthas into 100-octane gasoline

The HOUDRY ISO-PLUS Process reforms run-of-the-refinery, low-octane naphthas into gasolines with octane ratings in excess of F-1 clear. Variations of the ISO-PLUS Process yield from 86% to 91% of naphtha charge stock into 100-octane gasoline.

HOUDRY DEHYDROGENATION Process for single-step production of butadiene from normal butane

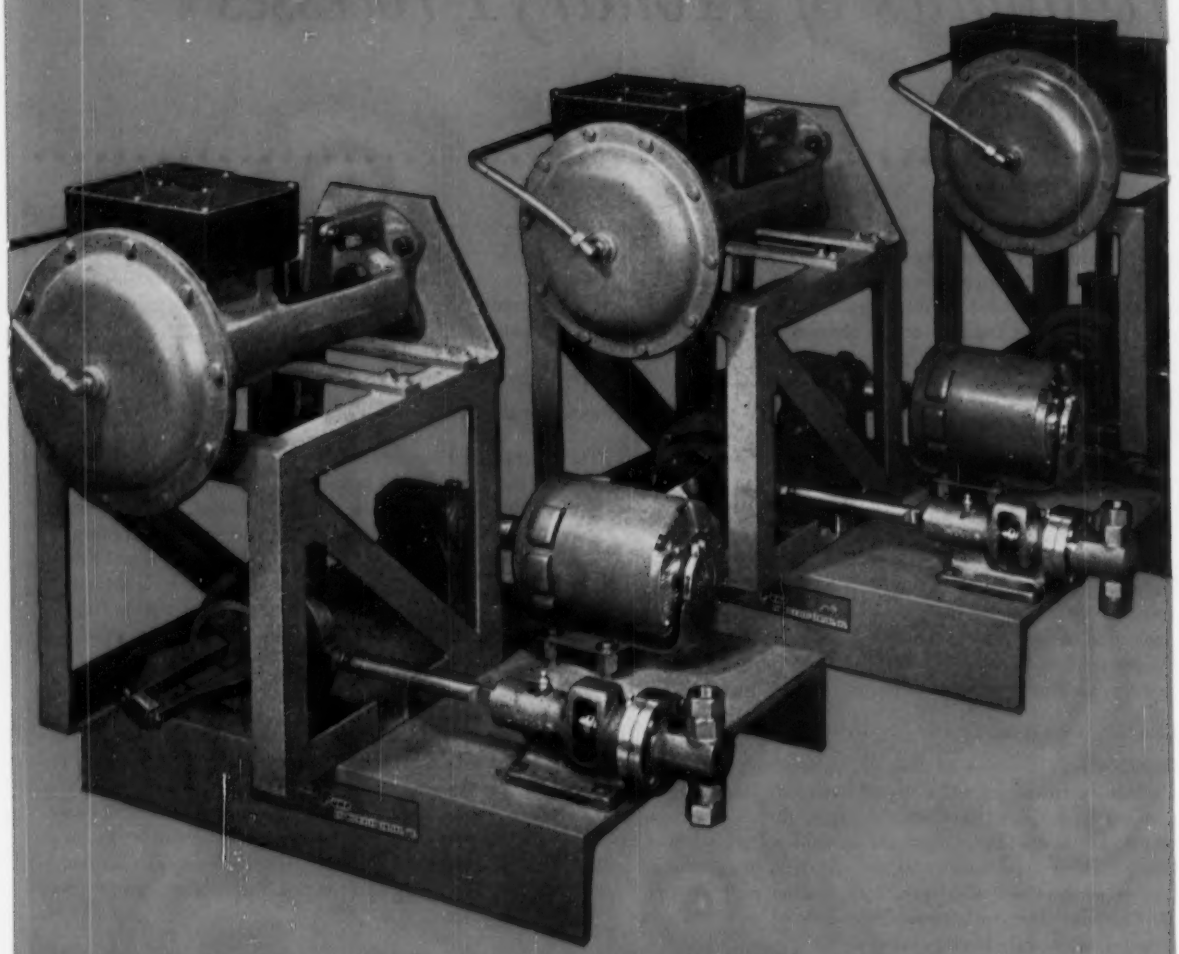
The HOUDRY DEHYDROGENATION Process is the only commercially-proved, single-step process for the production of either butylenes or butadiene from low cost butane. This process is also applicable to the production of propene from propane and isobutene from isobutane.

For further information on Houdry processes, services or catalysts, write to Houdry Process Corporation, 1528 Walnut St., Philadelphia 2, Pa.

HOUDRY
PROCESS CORPORATION
PIONEER IN CATALYTIC PROCESSES

For more data on advertised products, use Readers' Service Cards, last page.

Pumping Corrosion Inhibitors..



..with metering accuracy of 0.2%

thanks to **PHILATROL***

AUTOMATIC CAPACITY CONTROL

* Illustrated, pneumatically motivated with built-in square root extractor requiring 3 to 15 lb. signal. Also available electrically motivated—50 or 100 ohm slide wire. Hydraulically motivated —50 to 100 p.s.i. hydraulic fluid.

PHILADELPHIA PUMPS

PHILADELPHIA PUMP & MACHINERY CO. / Philadelphia 18, Pa. / Subsidiary of American Meter Co.

☆

Unit started up immediately . . .

☆

Down only 5 days in 8 months . . .

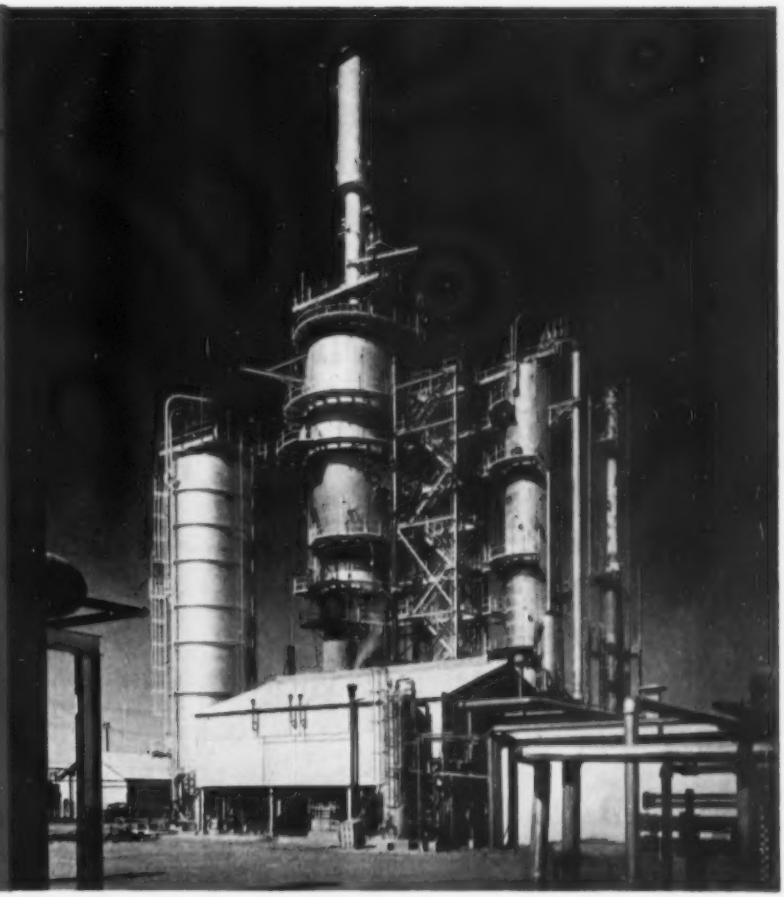
☆

Operating at 79% conversion . . .

☆

Output 10% above design rating . . .

☆



Champlin's Orthoflow* Proves Itself

FLUID CATALYTIC CRACKER

When Champlin Refining Company became part of The Chicago Corporation, up to $10 million was invested in a modernization program to expand capacity and raise octane level of its Enid, Oklahoma refinery. A major factor in minimizing initial cost of these facilities, and getting them on stream quickly and efficiently, was an Orthoflow Fluid Catalytic Cracker. Designed and built by The M. W. Kellogg Company for a fresh feed capacity of 9,000 BPD, and total throughput of 13,500 BPD, this Orthoflow also promises minimum maintenance.

The Orthoflow was erected by M. W. Kellogg well ahead of schedule, and went on stream without trouble immediately on completion. Within a month of initial operation, the unit fulfilled the Kellogg guarantees and was accepted. It operated continuously for 3 months, when repairs on the lube oil pump required a shutdown. This also permitted complete inspection of the interior of the Orthoflow, and reassured Champlin that the unit's lining and general condition were excellent. After 5 days, the unit was back in service, and ran without interruption for 5 months. Total time in service at this writing: 8 months. Total time out: only 5 days! The Orthoflow is now operating at 79% conversion rate, and about 10% above original design capacity.

The Champlin unit is one of seventeen Orthoflow Fluid Cat Crackers engineered or erected by The M. W. Kellogg Company for leading refiners throughout the world, with throughput capacities ranging from 3,500 BPD to 102,000 BPD. The trend toward this vertical-design cat cracker is graphically explained in a full-color, 15-minute animated movie. Refiners interested in seeing this film in their offices can make arrangements by contacting M. W. Kellogg.

Trademark of The M. W. Kellogg Company

Refinery Process Division

THE M. W. KELLOGG COMPANY

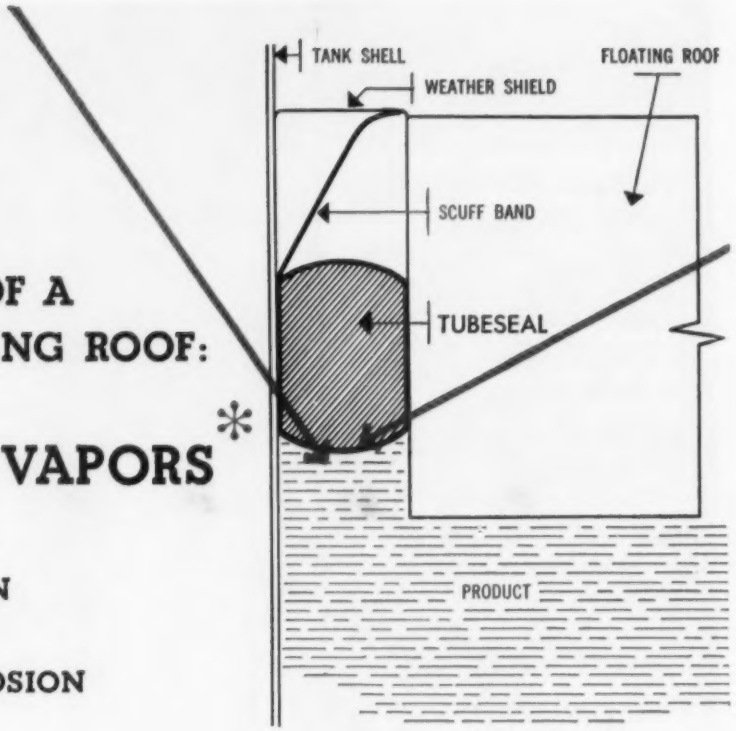
711 Third Avenue, New York 17, N. Y.

A SUBSIDIARY OF PULLMAN INCORPORATED

The Canadian Kellogg Company Ltd., Toronto • Kellogg International Corp., London • Kellogg Pan American Corp., New York
Societe Kellogg, Paris • Companhia Kellogg Brasileira, Rio de Janeiro • Compania Kellogg de Venezuela, Caracas

M KELLOGG W

For more data on advertised products, use Readers' Service Cards, last page.



THE SECRET OF A GOOD FLOATING ROOF:

NO ROOM FOR VAPORS

NO EVAPORATION
NO FIRES
MINIMUM CORROSION

Because there is no space in a HAMMOND TUBESEAL FLOATING ROOF, where vapor can form, jet fuels and other volatile products can be stored with assurance that evaporation and fires cannot take place and further that corrosion will be kept to a bare minimum.

THE HAMMOND TUBESEAL

The most efficient and positive seal known: no moving parts · no mechanical maintenance · climate proof · non-corrodible · can operate to bottom of tank or above the top · no vapor space below the seal · entire circumference has tight seal under pressure at all times.

LICENSES AVAILABLE

The makers of TUBESEAL believe that its unique safety and economy factors should be allowed to benefit the broadest possible section of the petroleum industry. For that reason HAMMOND IRON WORKS will license its use on a non-exclusive basis. For further information write to:

HAMMOND IRON WORKS,
Warren, Pa.

ask for Bulletin TS

HAMMOND TUBESEAL THE MOST EFFICIENT AND POSITIVE SEAL KNOWN

HAMMOND IRON WORKS

WARREN and BRISTOL, PA. • PROVO, UTAH • CASPER, WYO. • BIRMINGHAM, ALA.

Sales Offices:

BOSTON 10, MASS. • NEW YORK 20, N. Y. • CINCINNATI 2, OHIO • CHICAGO 3, ILL. • WARREN, PA. BRISTOL, PA. • ARLINGTON, VA. • GREENVILLE, S. C. • BIRMINGHAM, ALA. • SAGINAW, MICH. SAPULPA, OKLA. • PROVO, UTAH • CASPER, WYO. • LOS ANGELES 57, CALIF. • HAVANA • MEXICO CITY "TIPSA," BUENOS AIRES • CAIRO, EGYPT • PORT-AU-PRINCE, HAITI • LIMA, PERU

Licensees: CALIFORNIA, CANADA, ENGLAND, BELGIUM, GERMANY, ITALY, FRANCE, JAPAN

This is it...

the fast, efficient all-in-one pipe and bolt threader

... threads, cuts, reams!

Capacity: ⅛" to 2" pipe; ¼" to 2" bolts or rod.

New

RIDGID

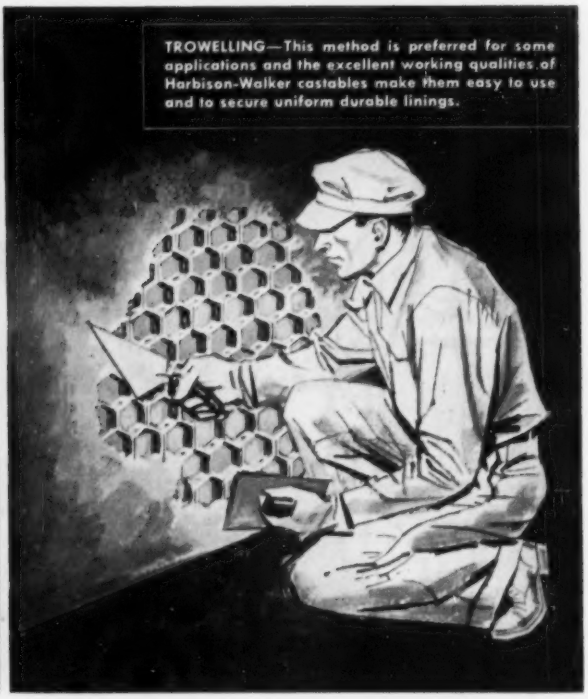
"Threaded Pipe—It's Tight—It's Best—Costs Less"

500A with SPEED CHUCK ... more clean smooth threads with less work ... a real work-saver in your refinery

New type wrenchless Speed Chuck operates easily, quickly, guaranteed to grip pipe or rod tightly—forward, reverse; jaws have replaceable insert teeth for longer life . . . Independent die heads, cutter, reamer swing up out of way when not in use; you can chuck pipe easily from front. All quick-opening die heads —any combination of sizes to meet your needs, Quadri, Dual or Mono heads for ⅛" to 2" pipe . . . quick size change right in machine . . . Power for geared tools to 12". Many other efficient worksaver features. See it, try it . . . buy it—at your Supply House.

The Ridge Tool Company, Elyria, Ohio, U. S. A.

GUN APPLICATION—For many installations, Harbison-Walker castables are used to best advantage with various types of air placement guns.



TROWELLING—This method is preferred for some applications and the excellent working qualities of Harbison-Walker castables make them easy to use and to secure uniform durable linings.

For refractory linings that last longer...
specify HARBISON-WALKER

H-W EXTRA STRENGTH CASTABLE

H-W 56 LIGHTWEIGHT CASTABLE

Cross-sectional view shows H-W 56 Lightweight (insulating) Castable next to the regenerator shell, with H-W Extra Strength Castable superimposed for the working lining, where its high strength, excellent erosion resistance and low coefficient of expansion all contribute to long service life.

Used together as illustrated, these two Harbison-Walker castable refractories form a lining that withstands the erosion, temperatures and pressures of refinery units, and provides highly effective insulation that reduces heat losses. Both products are particularly suited for service in catalytic cracking regenerators, reactors, catalyst feed lines and other units. They can be trowelled, poured like concrete, tamped or applied with air guns.

Write for complete information about these refinery-proved Harbison-Walker castable refractories.

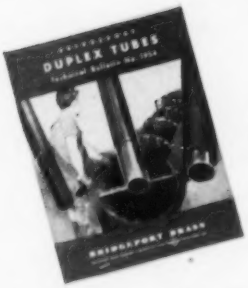
Harbison-Walker Refractories Company
AND SUBSIDIARIES
World's Most Complete Refractories Service
GENERAL OFFICES: PITTSBURGH 22, PENNSYLVANIA

WAYS TO LICK CORROSION!

Let **BRIDGEPORT** Help Find the Way That's Best for You

No pipe dream! Bridgeport Duplex Tube can help you lick dual corrosion conditions in more than 101*different* ways! Duplex Tube matches one alloy against inside corrosion and another alloy against outside corrosion. More than 101 Duplex combinations are available. Each is designed to lick a particular combination of corrosive conditions.

Whatever your corrosion problem, get in touch with Bridgeport. Write for our questionnaire which has been especially prepared to aid you in describing your corrosion problem. Our Corrosion Laboratory will be glad to help you select the tube alloys that will serve you best.



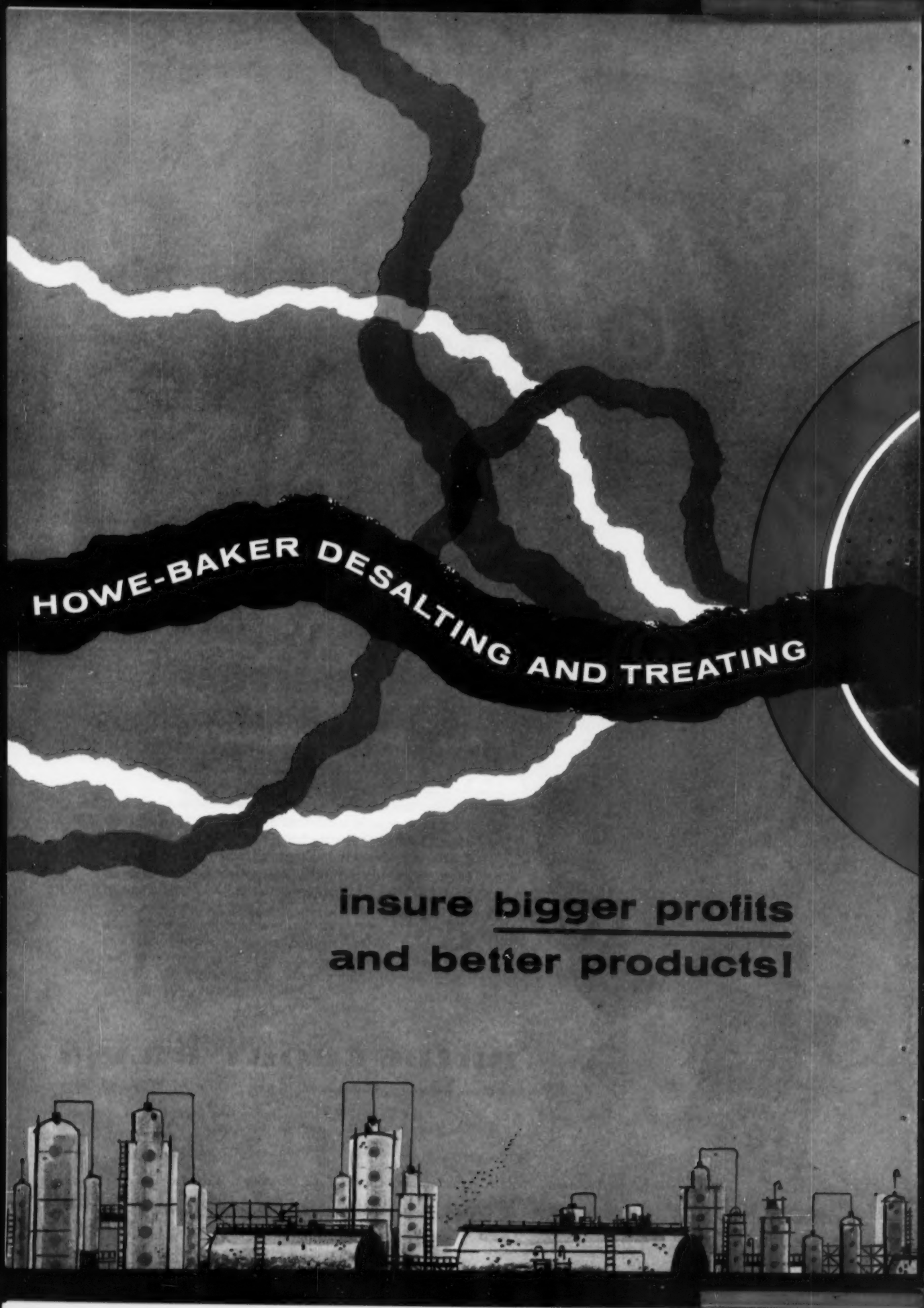
BRASS Bridgeport CO.

BRIDGEPORT BRASS

Bridgeport Brass Company, Bridgeport 2, Conn. • Offices in Principal Cities

In Canada: Noranda Copper and Brass Limited, Montreal

Dual corrosion and its prevention is discussed at length in Bridgeport's Duplex Tube Handbook. Write for your copy today.


HOWE-BAKER DESALTING AND TREATING
insure bigger profits
and better products!

A Howe-Baker Electrical Precipitation Unit May Be Installed In Your Existing Vessel

distillate treating

Use Howe-Baker's pilot units to find the answers to your distillate treating problems. You'll see how electrical precipitation antiquates all other methods of treating distillates.

Fully automatic, Howe-Baker's process insures a *high* and *consistent* product quality. High because electrical precipitation eliminates carry-over of the discontinuous phase, whether it be caustic, water or acid. Consistent because the automatic process assures uniformity.

Howe-Baker equipment saves money by reducing chemical consumption, pollution, maintenance costs and storage tank requirements; eliminating drying systems; and improving product quality. These savings are making bigger profits right now for many major oil companies.

Send for our brochure which describes the process in detail. Then use our pilot unit to test your feed stock, at no cost to you. The test will prove the worth of a Howe-Baker unit for your company.

electrical desalting

It is a proven fact that electrical desalting makes money for the refiner. Economic studies show that payouts will vary from a low of 60% per year to a high of 250%. A Howe-Baker installation will give you minimum gains of:

- 4.6c/bbl. from increased capacity
- 1.1c/bbl. from reduced maintenance
- 1.6c/bbl. from catalytic and thermal cracking operations
- 0.6c/bbl. from reduced corrosion
- 0.2c/bbl. from increased tank capacity
- 8.1c/bbl. Total Credit

At your request, a Howe-Baker representative will visit your plant to discuss your desalting problem with you. In the meantime, send for our electrical desalting brochure.

OVER 2 MILLION BARRELS OF CRUDE OIL PER DAY ARE BEING TREATED BY HOWE-BAKER ELECTROSTATIC UNITS

HOWE BAKER CORP.

Bank of the Southwest Bldg. • Houston 2, Texas

I'd like to have more information about how your processes can increase our profits. Please send me your

- ☐ distillate treating brochure
- ☐ electrical desalting brochure
- ☐ both

Name_____

Company_____

Street or P. O. Box Address_____

City_____ State_____ Country_____

Howe-Baker Corporation • Bank of the Southwest Bldg. • Houston 2, Texas

SETTING
NEW STANDARDS
OF PERFORMANCE...

Another
LUNKENHEIMER
FIRST!

THE
LQ600
VALVE

FIG. LQ600-200
200 lb. S.P.—400 lb. W.O.G.
550° F.

FIG. LQ600-150
150 lb. S.P.—300 lb. W.O.G.

¼ to 2 inches

Thousands of these valves have served for as long as five years without replacement, regrinding, maintenance, or leakage—even on the most severe services. Their patented Brinalloy* seats and discs are more resistant to wear and corrosion than 500 Brinell Stainless Steel . . . even outlast case-hardened Stainless Steel exceeding 1000 Brinell. LQ600 Valves practically eliminate maintenance costs!

*Patented Alloy—T. M. Reg.

SEE YOUR LUNKENHEIMER DISTRIBUTOR
or write for literature
THE LUNKENHEIMER CO., CINCINNATI 14, OHIO

LUNKENHEIMER®
THE ONE *Great* NAME IN VALVES

L-456-28

STRATCO
Reg. U. S. Pat. Off.

Effluent Refrigeration*

The Most Significant Improvement in

ALKYLATION

in Recent Years

A more efficient process for the production of 100 plus octane motor gasoline as well as aviation fuel and applicable to propylene as well as butylene alkylation.

Utilizes the heat of reaction to build up high isobutane concentration without evaporating isobutane from the reaction zone.

Results in lower capital investment and operating costs for a given yield, quality and catalyst consumption. Produces higher quality, with lower catalyst cost, for the same capital and operating outlay.

Adaptable to conversion or expansion of existing units as well as to new installations.

Seven plants now in operation; six under construction; ten in the planning stage.

We cooperate with the contractor of your choice in plant design.

*Licensed by Stratford Engineering Corporation

STRATFORD ENGINEERING Corporation

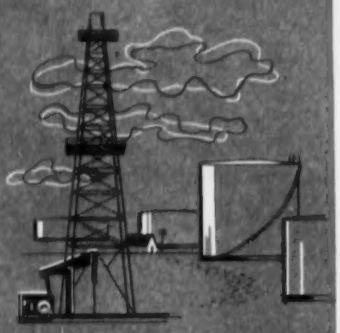
612 West 47th St. PETROLEUM REFINING ENGINEERS Kansas City 12, Mo.

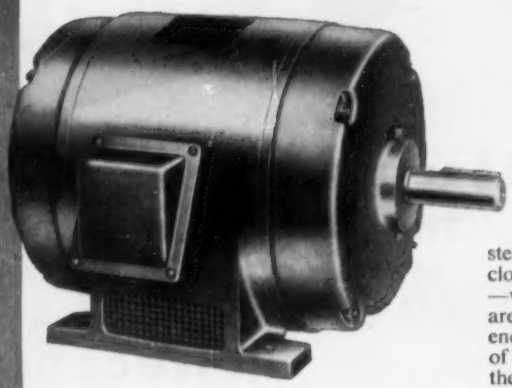
For more data on advertised products, use Readers' Service Cards, last page.

Wagner®
ELECTRIC MOTORS
...the choice of leaders in industry

there's a Wagner Motor for every job

...in the oil fields



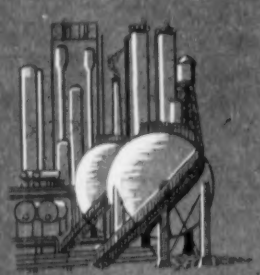


With single-phase Type DY capacitor start Motors, Wagner furnishes a separate weatherproof control box complete with starting and running capacitors and voltage relay.

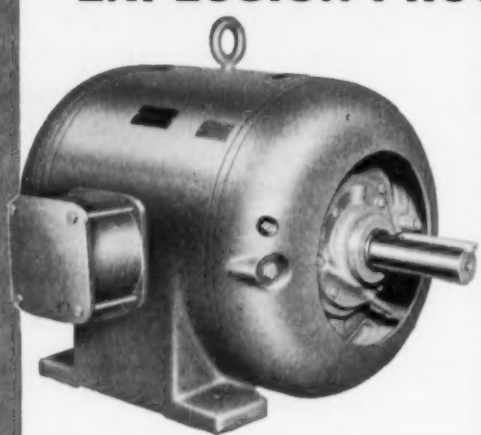
OIL WELL PUMPING MOTORS

Wagner cast-iron frame oil well pumping motors, either polyphase or single-phase, are especially designed for rugged, steady, outdoor service. The enclosures are completely drip-proof—virtually splash-proof. Air intakes are located at the bottom of the endplates to admit a cooling flow of air to the motor, while retarding the entrance of water. Outlets are located at the base of the frame, one on each side. Screened openings keep reptiles or small animals from entering the motor. The conduit box is moisture-proof and dust tight. For locations where only single-phase current is available, Wagner can furnish high power factor type capacitor-start motors with the same enclosures. You can get Wagner Oil Well pumping motors *from stock* in your immediate area.

...in the refinery



EXPLOSION-PROOF MOTORS



These powerful Type JP polyphase motors are expressly built for applications in explosive atmospheres. They are approved for Class I Group D hazardous locations. Totally-enclosed fan-cooled construction, with frames and endplates of cast iron, makes them suitable for indoor or outdoor use and for installations where corrosion is a problem. Available in ratings through 250 hp.

For full information, write for Bulletins MU-132 and MU-137. Thirty-two branch offices are ready to assist you in any motor application problem.

M56-13

Wagner Electric Corporation
6458 Plymouth Ave., St. Louis 14, Mo., U.S.A.

BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE SYSTEMS-AIR AND HYDRAULIC

Now...your own painter can "COLD-GALVANIZE" any steel surface with DIMETCOTE

* the 100% inorganic zinc coating

any PLACE

any TIME

any WHERE

SPRAY *or* BRUSH

Dimetcote is absolutely unique. It is not a paint, it contains no oils, resins or any other organic materials, yet it can be applied by spray or brush. When Dimetcote is applied to steel, a reaction takes place at the surface which produces chemical bonding as well as physical adhesion. It is almost impossible to find the interface between Dimetcote and the steel.

Dimetcote has many unusual characteristics. It shows no visible change after more than ten years exposure to the most severe weather conditions – sun, heat, fresh and salt water. It is insoluble in all solvents and petroleum products. It is highly abrasion resistant, but if abraded through to bare steel, the coating will cathodically inhibit corrosion.

Now tanks and structures can be given the same protection that galvanizing affords, *plus salt water resistance.* Existing structures need not be dismantled and new structures can be coated either before or after erection. *Only one coat* of Dimetcote over a sandblasted surface is required to protect such structures as:

Tank Exteriors • Cargo Tanks in Tankers • Dam Gates • Structural Steel • Christmas Trees • Buoys • Floating Roof Tanks • Offshore Rigs • Water Tanks • Barges • Ship Decks • Stacks

Write for the Dimetcote Technical Bulletin today.

Follow the line of MOST resistance: Amercoat® CORPORATION

4809 Firestone Blvd.,
South Gate, California

Evanston, Ill. • Kenilworth, N. J. • Jacksonville, Fla. • Houston, Tex.

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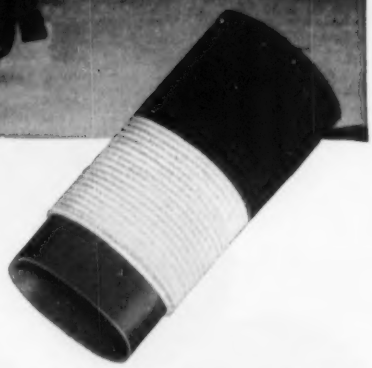
Quaker

Here's why this PETROCHEM fire hose is on guard throughout this D-X Sunray refinery



Get acquainted with your Quaker-Quaker Pioneer distributor. You'll find him of real help—not only for your regular needs — but also in emergency situations requiring extra fast supply. Write for free brochure and name of your nearest distributor.

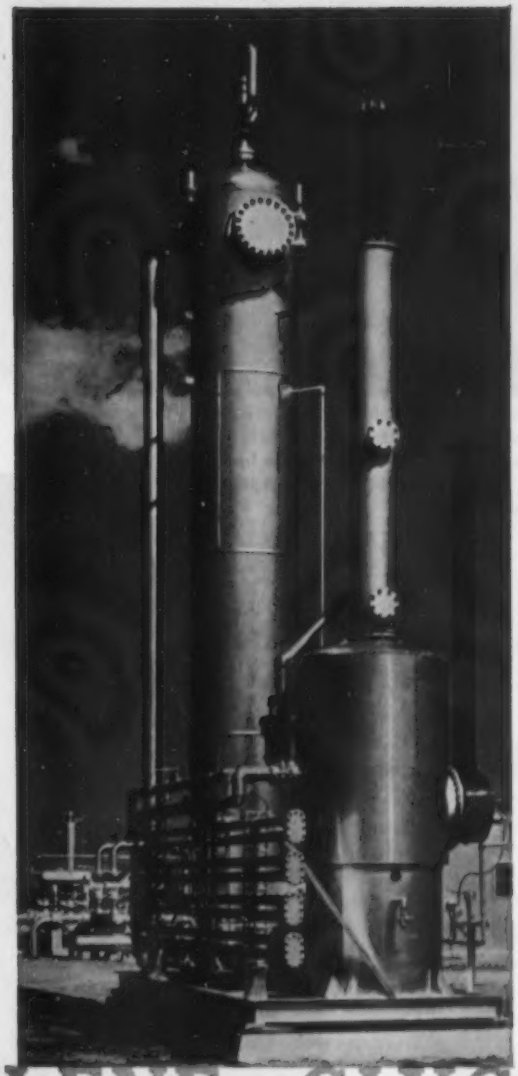
This hose does *more* than fight fire. It fights off deterioration by oil and chemicals, stands up to abrasion, resists weather and functions safely under high pressure. Why? Because its oil-resistant Neoprene tube is enclosed in tough, wear-defying *Du Pont Dacron* impregnated with oil-proof Neoprene . . . this provides a tough, light, flexible hose, resistant to oil, both inside and out. Actually this hose is so strong that it can take pressures up to 500 lbs. and temperatures up to 300°F. . . . and so flexible that you can actually knot it. Easy to store, too! Either coiled or folded it takes little space.

These are some of the reasons why D-X Sunray's Oklahoma refinery has this hose . . . the first made for oil and chemical industries, at all fire stations . . . and why it will pay you to consider it in your safety planning. Complete Quaker-Quaker Pioneer line includes hose for every purpose, belting, packing and moulded rubber for every use.

DIVISIONS OF HKP H. K. PORTER COMPANY, INC.

H. K. PORTER COMPANY, INC.
QUAKER RUBBER DIVISION
Philadelphia 24, Pa.
QUAKER PIONEER RUBBER DIVISION
San Francisco 7, California

Photo Courtesy of Blaw-Knox Company



gas
dehydration
at
lower
capital cost,
lower
operating cost
... with

TRIETHYLENE GLYCOL

- High dew point depression—50° to 85°F.
- Easily regenerated to 98-99% solution in an atmospheric stripper
- Stable in the presence of sulfur, oxygen, and CO_2 at normal operating temperatures
- Carry-over losses are small • Does not solidify in concentrated solution • Noncorrosive
- High theoretical decomposition temperature—404°F. • Low vaporization losses

Initial cost of a TEG dehydration plant is usually less than half that for certain types of dessicant plant. And operating costs are only ⅛ to ¼—with lower dessicant make-up cost. Our technical service man will be glad to consult with you if you're thinking about a new plant—or about the feasibility of converting an existing one.

If you currently use TEG, write for a typical analysis, quotation and free sample of our material. It's extremely low in iron, chlorides, acidity and water.

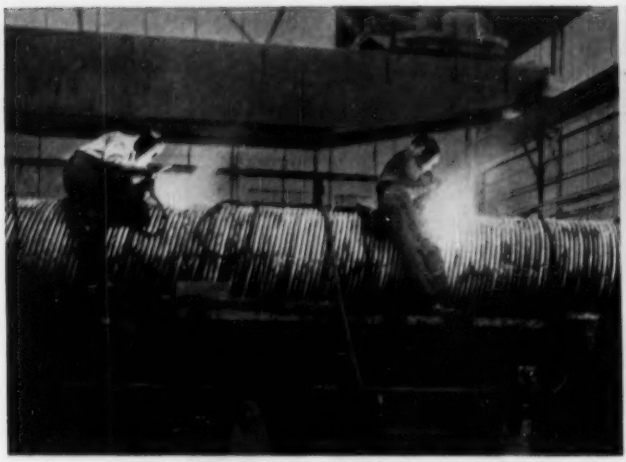
Dept. G 1-21-2

Allied Chemical — NITROGEN DIVISION

40 Rector Street, New York 6, N. Y.

Ethanolamines • Ethylene Oxide • Ethylene Glycols • Urea • Formaldehyde • U. F. Concentrate—85 • Anhydrous Ammonia • Ammonia Liquor • Ammonium Sulfate • Sodium Nitrate • Methanol • Nitrogen Solutions • Nitrogen Tetroxide • Fertilizers & Feed Supplements

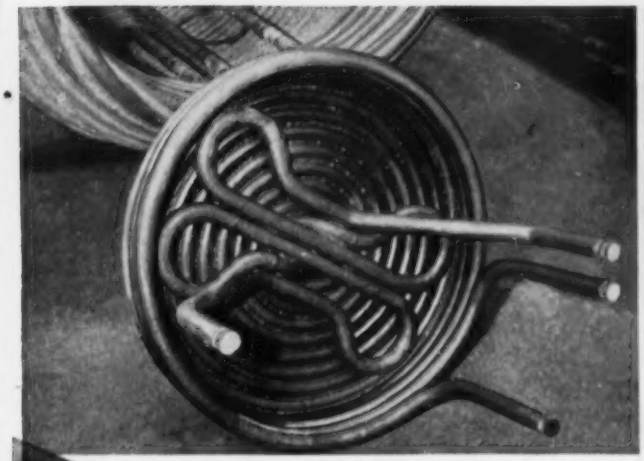
For more data on advertised products, use Readers' Service Cards, last page.



▲ In the fabrication of special combination reactor and heat exchanger, thousands of feet of tubing had to be precisely wound into a helix to form a baffle. The seam of the helix was completely welded inside and out.

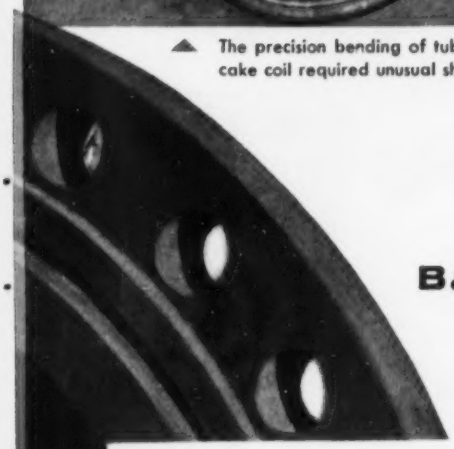
▲ B&W pioneered the development of pressure vessel welding. Here an experienced hand welder is working on alloy header protection plates.

▶ Measuring peep sight coils, which are located in manway of main drum.



▲ The precision bending of tubing to form this pancake coil required unusual shop skills.

▲ Manufacture of the header protection coil involved many special techniques in bending and welding.



B&W's *Engineering and Manufacturing Skills Produce Something New and Different In*

PRESSURE VESSELS...

Designing and manufacturing the equipment for a special combination reactor and heat exchanger for a petro-chemical plant required something unusual in the way of engineering and manufacturing skills. B&W design and manufacturing engineers contributed materially to the solution of these problems through their techniques, skills and depth of experience accumulated in producing thousands of pressure vessels, boilers, refractories, burners and tubing, of all types and for virtually every application.

The design and fabrication of this complex unit is but one example of how B&W blends engineering skills and unexcelled facilities—backing both with continuing research in many areas. Because B&W has long been meeting the special requirements of modern chemical, petroleum and steam generating operations, you will receive the ultimate in engineering and experienced craftsmanship when you bring your process equipment problems to B&W. The Babcock & Wilcox Company, Process Equipment Department, Barberton, Ohio.

BABCOCK & WILCOX

BOILER DIVISION

S-456

For more data on advertised products, use Readers' Service Cards, last page.

Stems can't seize...

ALL-IRON TRIM, FIG. 337

BRONZE TRIM FIG. 333

Both of these OIC Duo-Bolt gates have special stems. The Fig. 333 stem is OIC *Alloy-40* in sizes 2″ and under . . . corrosion-resistant bronze with 20 to 30 times longer life than most other stem bronzes. It will not gall or seize. In fact, this alloy has all but eliminated stem replacement. The Fig. 337 stem is nickel-plated steel . . . highly resistant to pitting in the packing area, sturdy and long wearing.

Design includes bonnet drain ducts . . . recessed gasket seat

To protect against freezing, bonnet ducts allow complete drainage of the upper part of the valve. The male-female, gasketed body-bonnet connection assures a tight joint and prevents blown gaskets.

Exclusive cast-in seat rings

On sizes 2″ and under, bronze trimmed valves include cast-in seat rings, *rolled* to make doubly sure that they cannot loosen in service. On sizes 2½″ and larger, seat rings are screwed in. Seats are integral on all-iron trim valves. Both types include a button-head stem-to-wedge connection, flexible for non-binding wedge seating.

Immediate availability . . . long line

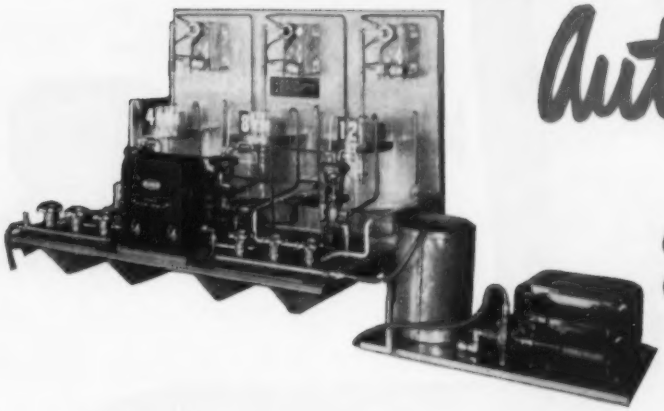
Order Duo-Bolt gates from your OIC Distributor or his field store. Sizes: ¼″ to 4″, screwed or flanged ends. Working pressures: 125 to 150 lbs. WSP, 200 to 225 lbs. cold WOG, non-shock. Request Form No. 1007 for more information.

THE OHIO INJECTOR COMPANY • WADSWORTH, OHIO

VALVES | **FORGED & CAST STEEL, LUBRICATED PLUG, BRONZE & IRON VALVES**

MECO Integrated SERVICE

INTRODUCES THE NEW



Automatic Tank Switching Unit

Prime example of MECO engineering — integrating precision components into flexible production units — is the new tank switching unit, in which a single selector-controller is used for a multiple tank battery operation.

It is composed of (1) Masoneilan Automatic Selector-Controller (designed to carry two to twelve tanks in one battery), (2) liquid level controllers, (3) interlocks which hold the fill-valve closed when oil is drained to pipeline or recirculated, (4) pressure gauges showing whether tank is being filled, drained or recirculated.

Entirely pneumatic with selector-controller and gauges panel-mounted, the unit may be operated by compressed air or gas. The Masoneilan Selector-Controller has a standard weatherproof case and non-bleed pilot features, and provides continuous scanning of all tanks in the battery.

The assembly is available from stock as a complete package with interlocking features and standard components known for their durability, compactness, and dependability.

The complete working model of the MECO Automatic Tank Switching Unit is on tour in Texas, Louisiana and Mississippi. Dates for demonstrations in your area are available on request.

OFFICES:

Corpus Christi, Texas
P. O. Box 1552, Phone: TU 3-6446

Shreveport, Louisiana
P. O. Box 175, Phone: 3-2387

For detailed information, write, wire or phone:

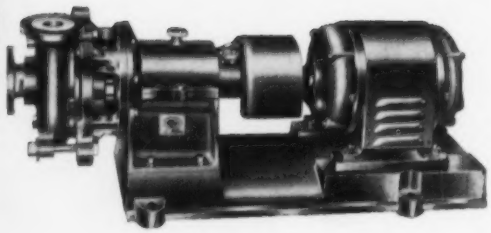
CA 2-2351

MECO MAINTENANCE Engineering CORPORATION
P. O. BOX 2657 — 3711 CLINTON DRIVE HOUSTON, TEXAS

SUBSIDIARY: Coastal Engineering Corporation
P. O. Box 11036, Phone EX-2194
New Orleans, Louisiana

WILFLEY

Acid Pumps Give You LOWER Pumping Costs



"COMPANIONS IN ECONOMICAL OPERATION"
Wilfley Acid Pump
Wilfley Sand Pump

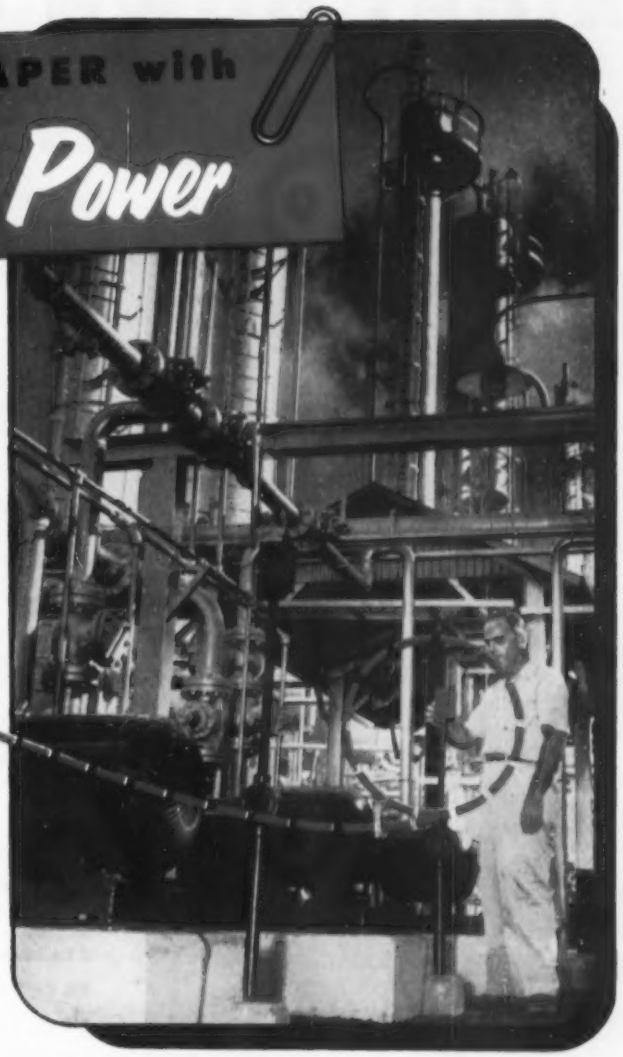
Write, wire or phone for complete details.

A. R. WILFLEY and SONS, Inc.
DENVER, COLORADO, U.S.A.
New York Office: 1775 Broadway, New York City

True pumping economy is a reality when you install Wilfley Acid Pumps. These rugged, heavy-duty pumps give you 24-hour, **trouble-free** operation. Production records **prove** that Wilfley provides the ultimate in pumping efficiency. Available with pumping parts of the machinable alloys as well as plastic to meet all requirements.

Individual Engineering on Every Application

You can do it CHEAPER with
UTILITY Electric Power



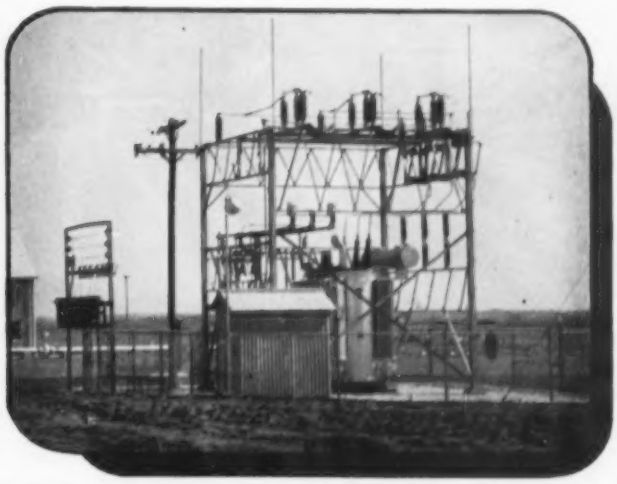
Low Cost Power!

Utility Electric Power gives you just that . . . PLUS MORE! Wherever oil is lifted, moved, or refined, Utility Electric Power will do a great job! Low initial cost . . . low maintenance and operating costs . . . complete dependability around the clock . . . safety, convenience and automatic control to meet your power requirements. Yes, these advantages are yours when **Economical** Utility Electric Power is specified.

Petroleum Electric Power Association

P. O. BOX 2771, DALLAS, TEXAS
ORGANIZED IN THE INTEREST OF GREATER SERVICE TO THE PETROLEUM INDUSTRY

CALL YOUR LOCAL ELECTRIC SERVICE COMPANY for POWER FACTS



RIGHT DOWN OUR ALLEY

This is "pipe alley" in a large Midwestern refinery. It is made up of connecting lines between refinery units and storage tanks. Such "pipe alleys" are highly practical to a refinery since all the pipe is confined to one area, and the lines are kept above-ground where they are easily accessible for inspection and maintenance.

Over 70,000 feet of the pipe in this alley is NATIONAL Seamless, "Walls Without Welds," 12¾-inch O.D. with .375-inch wall.

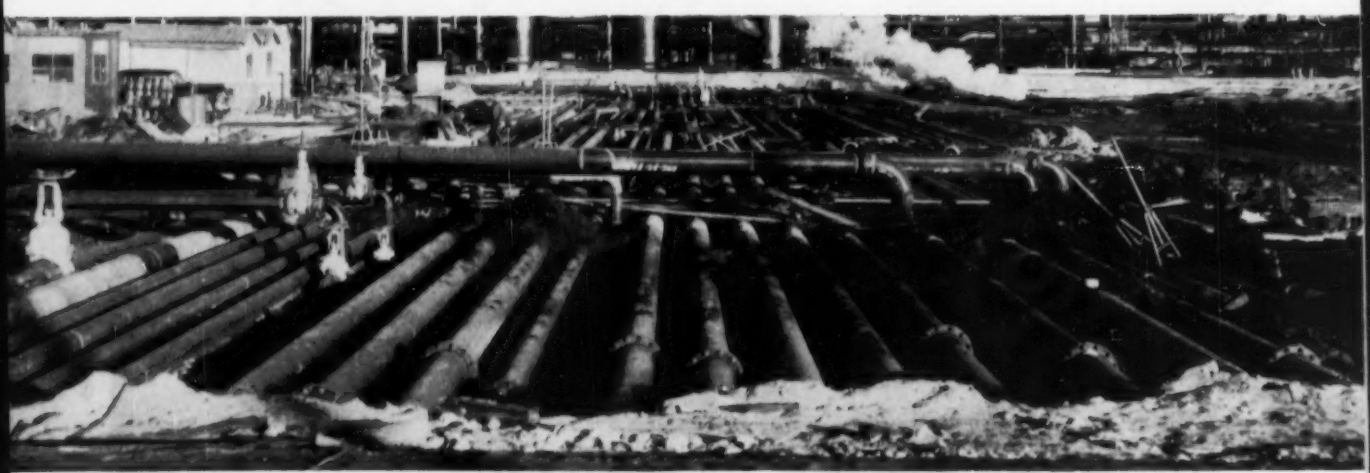
* * *

Refinery pipe and tubing problems are "right down our alley." We manufacture NATIONAL Seamless Pipe and Tubes in over 2 dozen different steel analyses, each designed to counteract specific refinery problems such as corrosion, oxidation, pressure and temperatures. Other chemical compositions are also available in tubular products, and at the present time, a wide variety of high temperature problems is under study.

If you have a refinery tubing problem, we'd like to give you a hand with it. We have a technically trained Mill Service Force available to you for technical and operating assistance in meeting your tubular requirements. This Force is also available for consultation in the field. We'll see that you get the right tubing for the job, at the lowest cost. Write to National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa.

TWO DOZEN DIFFERENT NATIONAL TUBE ANALYSES:

Carbon	5 Cr, ½ Mo	17 Cr
Carbon, ½ Mo	5 Cr, ½ Mo, 1½ Si	18-8
1 Cr, ½ Mo	7 Cr, ½ Mo	18-8 Ti
1¼ Cr, ½ Mo	8 Cr, ½ Mo	18-8 Cb
2 Cr, ½ Mo	8 Cr, 1 Mo	18-8 Mo
2¼ Cr, 1 Mo	9 Cr, 1 Mo	25-20
2½ Cr, ½ Mo, ¾ Si	12 Cr	3½ Ni
3 Cr, 1 Mo	12 Cr, Al	5 Ni



NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
(Tubing Specialties)
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS · UNITED STATES STEEL EXPORT COMPANY, NEW YORK

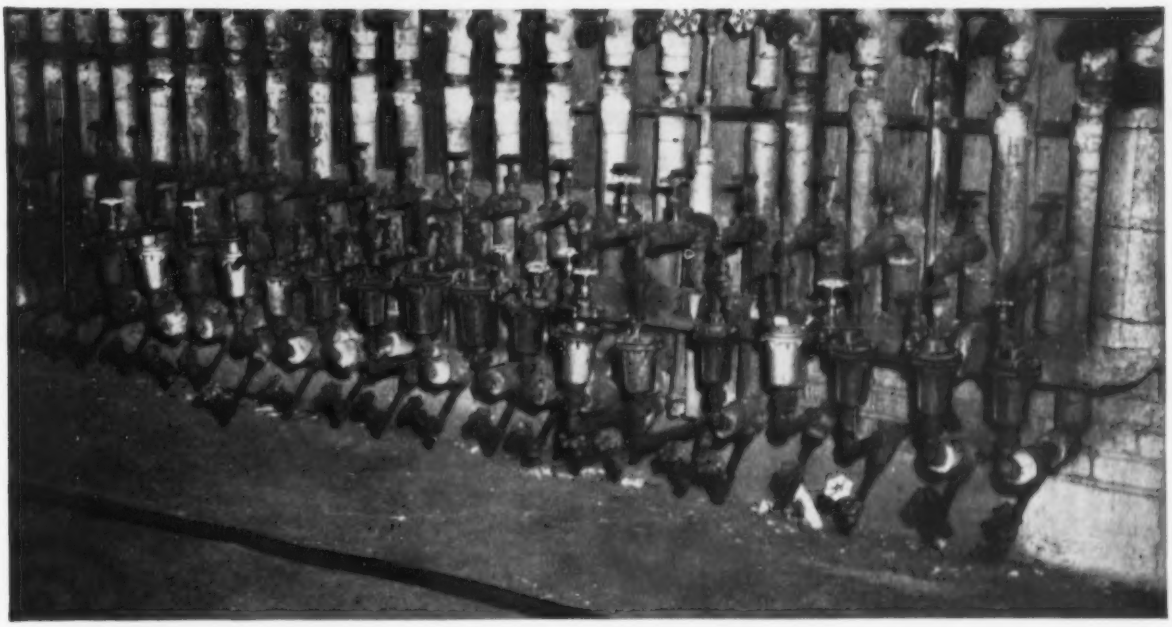
USS

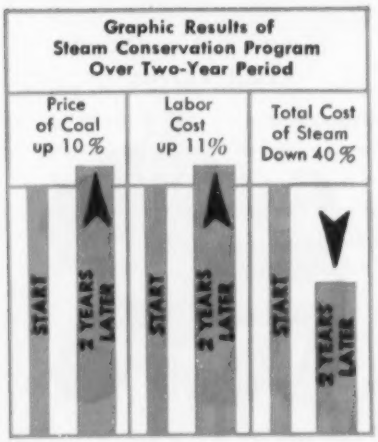
NATIONAL SEAMLESS PIPE AND TUBES

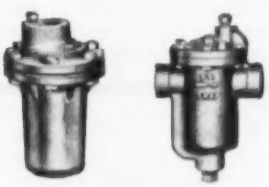
SEAMLESS WITHOUT WELDS

UNITED STATES STEEL

How a Major Chemical Company Cut Steam Costs $100,000 Annually







Trap sizes and styles
for every condensate drainage job.

Armstrong Traps were a "Major Factor" in Steam Conservation Says Chief Engineer

Steam waste has a way of creeping up on you. Especially in older plants. The losses can make a staggering total.

Plants looking for a way to fight rising costs can well take a page from the 8-point steam conservation program that netted a major chemical plant $100,000 annual saving:

1. **Waste steam utilized** — all flash steam recovered for building heating.
2. **New steam traps installed** — Armstrong traps replaced old traps throughout the plant, indoors and out.
3. **Steam leaks repaired.**
4. **Insulation repaired.**
5. **All condensate recovered.**
6. **Steam piping simplified.**
7. **Steam turned off when not needed.**
8. **Preventive maintenance improved** to insure a continuous checkup on sources of waste.

In commenting on the program, the Chief Engineer of the plant stated, "*4000 new Armstrong steam traps were one of the major factors in conserving steam. The traps, plus improved installation practice, have reduced annual trap maintenance parts and labor by $25,000 as compared to traps previously used.*"

Want all the facts? Tips on cost-saving standardized trap hookups? Facts about Armstrong traps? Ask for:

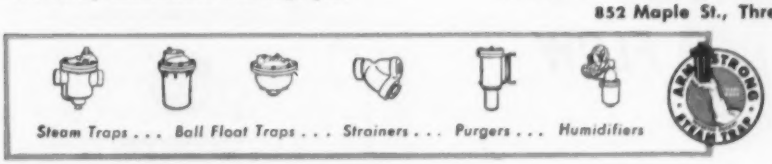
1. The No. 1, 1956 issue of the Armstrong Trap Magazine containing complete details, drawings and photos.

2. The 44-page Armstrong Steam Trap Book, a fact-full guide to better trapping.

Call your local Armstrong Representative or write:

ARMSTRONG MACHINE WORKS

852 Maple St., Three Rivers, Michigan



ARMSTRONG STEAM TRAPS

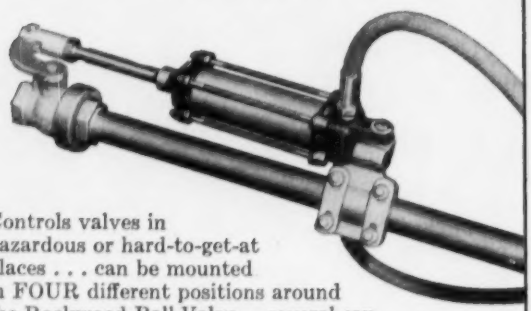
For more data on advertised products, use Readers' Service Cards, last page.

Rockwood Ball Valves

- *Full round pipe size flow*
- *Leakproof service*
- *¼ turn opening and closing*
- *No maintenance*

Air-Operated Ball Valves

For remote control use

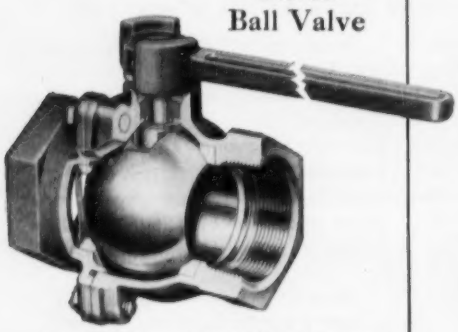


Controls valves in hazardous or hard-to-get-at places . . . can be mounted in FOUR different positions around the Rockwood Ball Valve . . . several can be controlled from one control board . . . available in a complete package unit from your distributor.

Male Thread Bronze Ball Valve

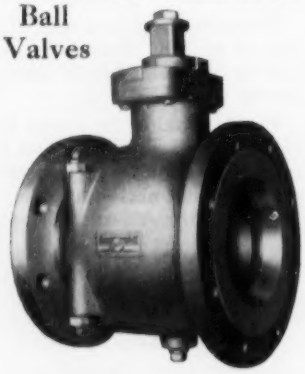
Full flow . . . with thread end, flanged end, union end or combination of same available with this valve. Longer life . . . greater strength. Size 2½" only.

Steam Ball Valve

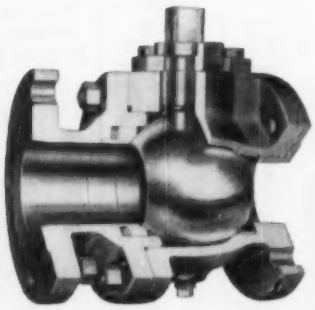


New Rockwood Ball Valve for use with steam handles up to 125 pounds of steam per square inch and 350 degrees F, with ease . . . opens and closes quickly. Pipe sizes ⅜" to 2".

6" and 8" Cast Steel Ball Valves



3" and 4" Cast Steel Ball Valves



Combines best features of plug cocks, gate and globe valves . . . made of medium carbon cast steel that meets specifications for carbon steel pressure castings as embodied in ASTM. Also made in other materials.

ROCKWOOD BALL VALVES

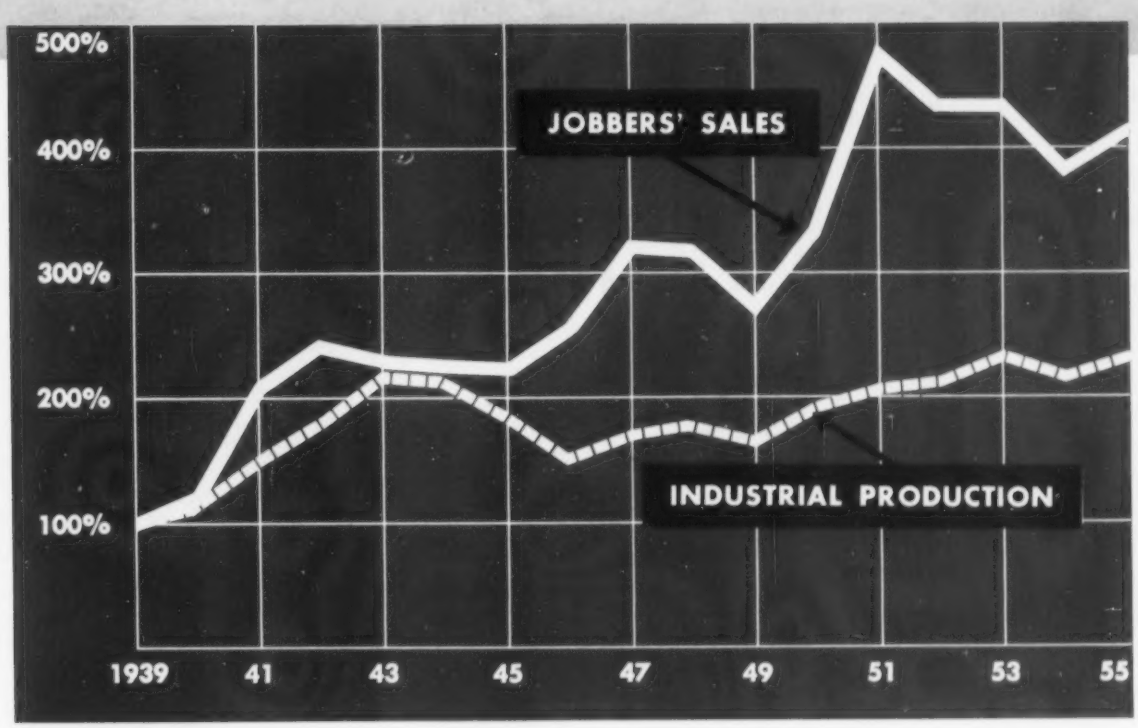
FULL, ROUND FLOW

Write for complete data to Rockwood Sprinkler Company, 1284 Harlow St., Worcester 5, Mass. Distributors in all principal industrial areas.

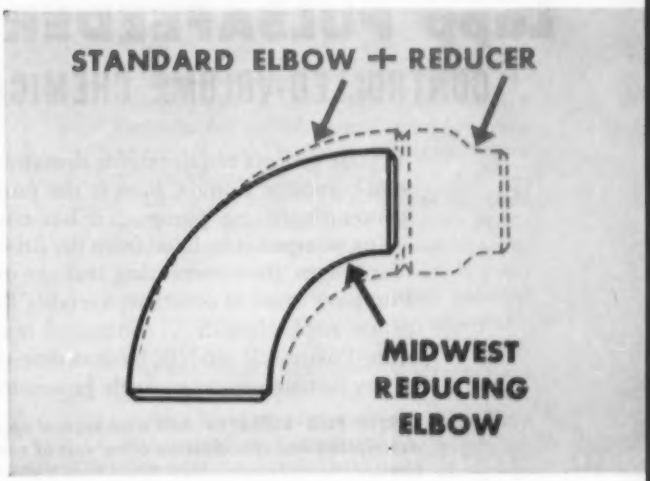
ROCKWOOD

Tested and listed by Underwriters' Laboratories, Inc.

JOBBERS Prevent Hardening of the ECONOMIC ARTERIES



The chart above shows that the jobber is now handling a larger share of industrial goods than ever before. Users are finding it to their advantage to look to him for more of their needs. The jobber reduces the user's inventory, assures prompt delivery, provides technical assistance when needed . . . and many other benefits. Are you using him to your own best advantage?



MIDWEST

Jobbers Save You Money, Time and Trouble on Welding Fittings

Midwest Jobbers have the most complete line of welding fittings . . . which often permits them to improve or simplify piping. Only Midwest jobbers offer you a full size range of reducing elbows that take the place of two fittings . . . a straight elbow and a reducer, thus saving space and one weld. There are many other advantages to be gained by using Midwest Welding Fittings . . . see for yourself . . . ask for Catalog 54.

MIDWEST PIPING COMPANY, INC.

Main Office: 1450 South Second Street, St. Louis 4, Mo.

Plants: St. Louis, Clifton, N.J. and Los Angeles

Sales Offices:

New York 7—50 Church St. • Chicago 3—79 West Monroe St.
Boston 27—426 First St. • Los Angeles 33—520 Anderson St.
Houston 2—1213 Capitol Ave. • Tulsa 3—224 Wright Bldg.
Cleveland 14—616 St. Clair Ave. • Miami 34—2103 Le Jeune Rd.

STOCKING DISTRIBUTORS IN PRINCIPAL CITIES

7416,

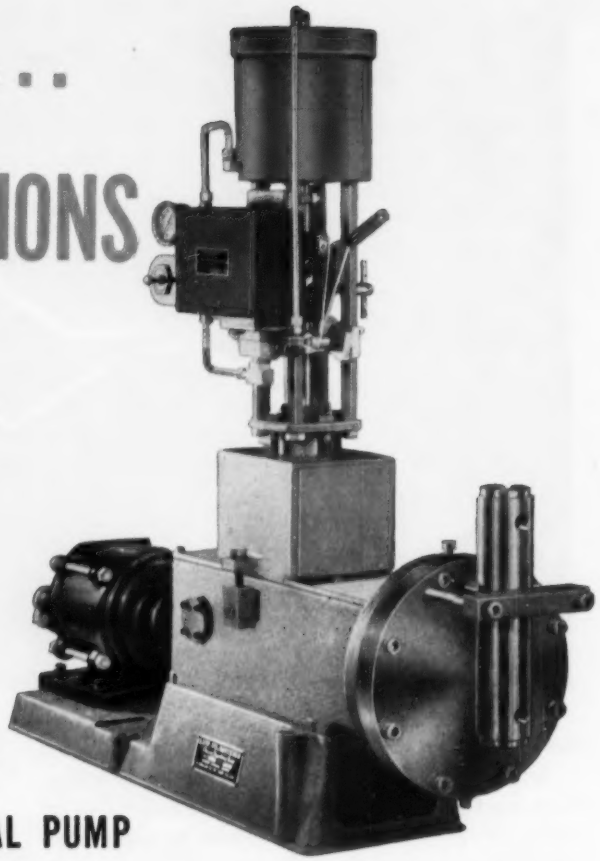
IT PUMPS...

IT METERS...

IT PROPORTIONS

IT FEEDS...

WITHOUT LEAKAGE OR CONTAMINATION



Lapp PULSAFEEDER

CONTROLLED-VOLUME CHEMICAL PUMP

If your process requirements demand accurate handling of corrosive and non-corrosive liquids, here is the pump for the job. The Lapp Pulsafeeder is a piston-diaphragm pump . . . it has positive displacement with *no stuffing box.* The product being pumped is isolated from the drive mechanism by a hydraulically balanced diaphragm, thus preventing leakage or contamination of the product. Pumping speed is constant; variable flow results from variation in piston-stroke length . . . controlled manually by hand-wheel, or, in Auto-Pneumatic models, by instrument air pressure responding to any instrument-measurable processing variable.

WRITE FOR BULLETIN 440 *with typical applications, flow charts, description and specification of models of various capacities and constructions. Inquiry Data Sheet included from which we can make specific engineering recommendation for your processing requirement. Write Lapp Insulator Co., Inc., Process Equipment Division, 65 Wilson Street, Le Roy, N. Y.*

Lapp

PLATINUM RECOVERY

COMPLETE FACILITIES FOR PROMPT, EFFICIENT RECOVERY OF PLATINUM METALS FROM SPENT CATALYST

Here, a modern PLATINUM METALS refining plant is provided with special facilities for sampling and recovery from spent catalyst. Baker guarantees 100% return of assayed content.

Our plant is geared to assure dependable service which will free your PLATINUM to manufacture fresh catalyst without unnecessary delay. Baker is also prepared to manufacture fresh catalyst in any required concentration of metal—in the form and on the carrier you specify.

If you would like detailed information on Baker Catalysts and our Catalyst Recovery Service, your inquiry will receive our immediate attention. ★ ★ ★ ★

Literature on Platinum Metals Catalysts is available and will be sent at once, upon request.

BAKER & COMPANY, INC.
CATALYSTS

113 ASTOR STREET · NEWARK, N. J.

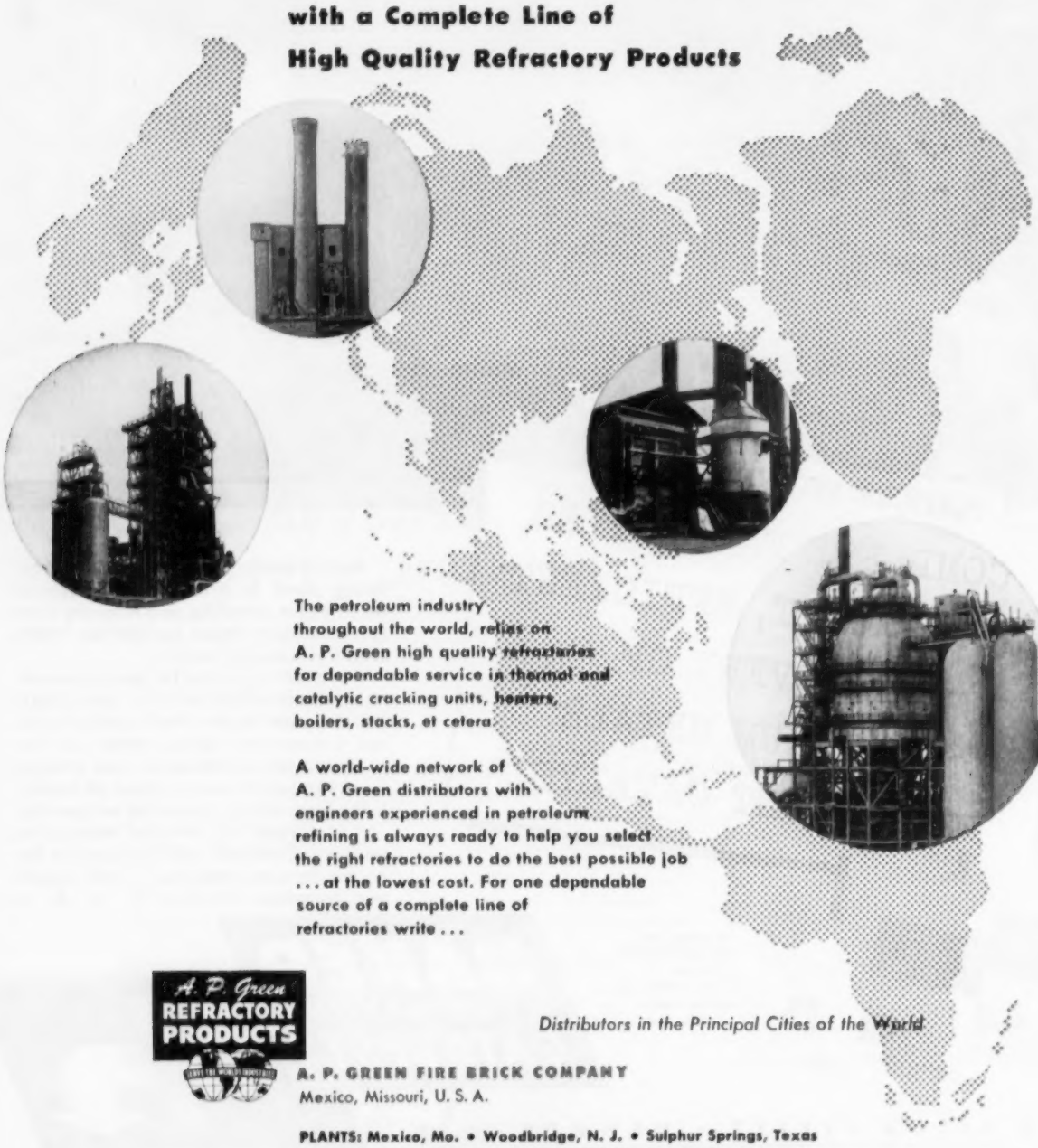
ENGELHARD INDUSTRIES

THE HUB OF PLATINUM METALS RESEARCH

throughout the world...

A. P. GREEN

Serves the Petroleum Refining Industry with a Complete Line of High Quality Refractory Products



The petroleum industry throughout the world, relies on A. P. Green high quality refractories for dependable service in thermal and catalytic cracking units, heaters, boilers, stacks, et cetera.

A world-wide network of A. P. Green distributors with engineers experienced in petroleum refining is always ready to help you select the right refractories to do the best possible job . . . at the lowest cost. For one dependable source of a complete line of refractories write . . .

A. P. Green REFRACTORY PRODUCTS

Distributors in the Principal Cities of the World

A. P. GREEN FIRE BRICK COMPANY
Mexico, Missouri, U. S. A.

PLANTS: Mexico, Mo. • Woodbridge, N. J. • Sulphur Springs, Texas
In Canada: **A. P. GREEN FIRE BRICK COMPANY, LTD.** Toronto 15, Ontario
In England: **LIPTAK FURNACE ARCHES, LTD.** London, England

THE STONE & WEBSTER RIPPLE TRAY*

A Notable Development for the Process Industries

BELOW:
Ease of installation is a plus factor for Stone & Webster Ripple Trays.

The unique RIPPLE TRAY, developed and designed by Stone & Webster Engineering Corporation, brings new concepts of economy and efficiency to fractionation.

The high capacity and simplicity of construction of RIPPLE TRAYS have effected major savings in first cost over conventional bubble cap trays. Full tower cross section is utilized for active contact of liquid and vapor. No downcomers are required.

Because of their unusual self-cleaning feature, downtime for maintenance of RIPPLE TRAY-equipped fractionation units is reduced to a minimum.

Efficiency maintained over a wide operating range makes RIPPLE TRAYS adaptable to practically every type of service.

Commercial performance has established their acceptance in the process industries.

Write or call us for information as to how our broad experience in the process field can help you.

*Trade-Mark

STONE & WEBSTER ENGINEERING CORPORATION

A SUBSIDIARY of STONE & WEBSTER, INC.

New York Boston Chicago Pittsburgh Houston San Francisco Los Angeles Seattle Toronto

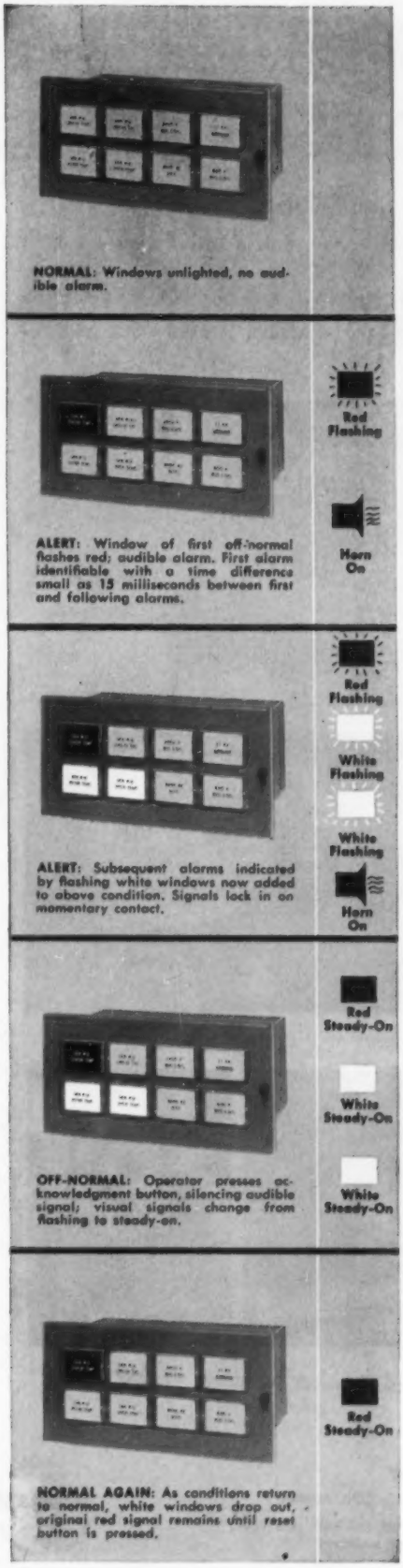
HYDROCRANE'S WORKING BOOM HOIST
Speeds Refinery Digging, Lifting Jobs

With the Hydrocrane, *any* boom angle is a working position because the boom is raised or lowered dozens of times a day as part of the crane's regular operating cycle. Even with full load suspended, you can raise or lower boom, and swing or telescope *at the same time,* with the precise control that only the Hydrocrane offers. It's just one of the many unique, time-saving features that make the Bucyrus-Erie Hydrocrane the ideal refinery tool.

You also gain many advantages working in confined areas. The Hydrocrane's working boom hoist, together with the line hoist, lifts the load over stockpiles and ground obstructions, under overhead steam or other pipe lines as it swings to the spot . . . and places it in position positively and quickly. Hydrocrane's rugged outriggers, which permit conventional motor truck mounting, give you an unusual combination of high capacity and top mobility. Extremely short tail swing lets you put the crane in the tightest spots.

Hydrocranes are now available in two sizes — the 5-ton H-3 and the 9-ton H-5. See one in action soon — arrange for a demonstration with your Bucyrus-Erie distributor. 135H56

BUCYRUS • ERIE COMPANY • South Milwaukee, Wisconsin


NORMAL: Windows unlighted, no audible alarm.
Red Flashing
Horn On
ALERT: Window of first off-normal flashes red; audible alarm. First alarm identifiable with a time difference small as 15 milliseconds between first and following alarms.
Red Flashing
White Flashing
White Flashing
Horn On
ALERT: Subsequent alarms indicated by flashing white windows now added to above condition. Signals lock in on momentary contact.
Red Steady-On
White Steady-On
White Steady-On
OFF-NORMAL: Operator presses acknowledgment button, silencing audible signal; visual signals change from flashing to steady-on.
Red Steady-On
NORMAL AGAIN: As conditions return to normal, white windows drop out, original red signal remains until reset button is pressed.

Panalarm "VS" Annunciator identifies first off-normal from subsequent alarms for rapid corrective action

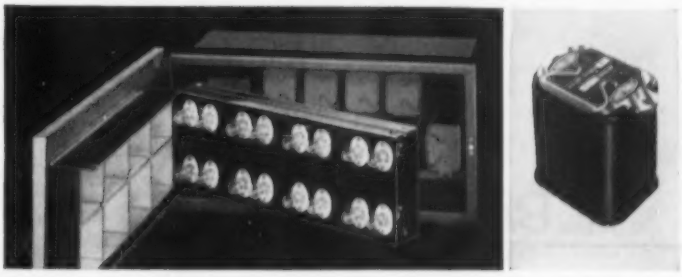
You gain the control advantages of an audio-visual information system, not just an alarm system, with the Panalarm "50VS" Visual Sequence Annunciator. This is particularly valuable when one off-normal condition will cause a "chain-reaction" of off-normals. Typical Panalarm applications are found in the process industries and among users of automatic machinery.

The original off-normal is clearly identified, enabling the operator to take immediate, corrective action. A considerable saving in down-time can often be effected simply by knowing the original source of trouble.

Panalarm "50VS" is completely flexible in setting up various sequential groups. Any number or combination of signals may be grouped as an independent sequence, and the groupings may be changed at any time by simple jumpers on the terminal block. Signals may be either illuminated nameplate or bullseye indicators, combined with a horn, bell or other audible signal. Signaling is simple and positive. A typical sequence is illustrated on the left.

Write for literature on the "50VS" and other Panalarm Annunciator Systems. A Panellit sales engineer will be happy to make a survey of your production operation to determine whether a Panalarm system can help increase efficiency and safety in your plant.

All Panalarm Annunciator Systems are completely modular, permitting future growth and changes. The photographs below illustrate a typical Panalarm Cabinet with illuminated nameplates and the hermetically sealed Panalarm "50" plug-in relay unit. Components throughout are ruggedly built to instrument standards for continuous, dependable duty. Entire Panalarm system is suitable for Class 1, Division 2 installations.

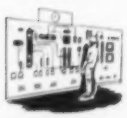


Listed by Underwriters' Laboratories

U.S. Patent No. Re-24,031

Engineered Information Systems for Industry

Panalog Information Systems



Graphic Panels Control Centers

Instrument Services Division

PANALARM

Division of

PANELLIT, INC.

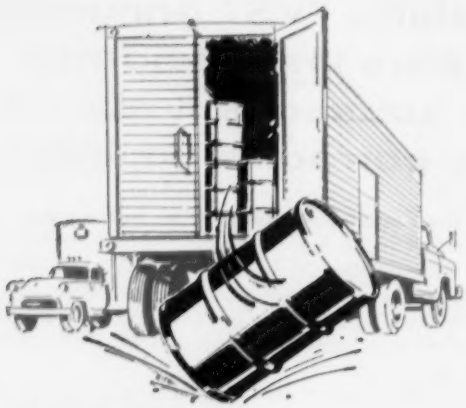
7415 N. Hamlin Ave.

Skokie, Ill.

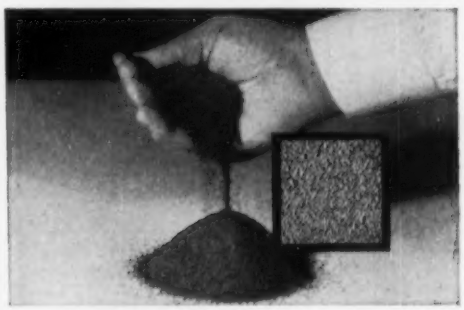
Panellit of Canada Ltd. Toronto 14

For more data on advertised products, use Readers' Service Cards, last page.

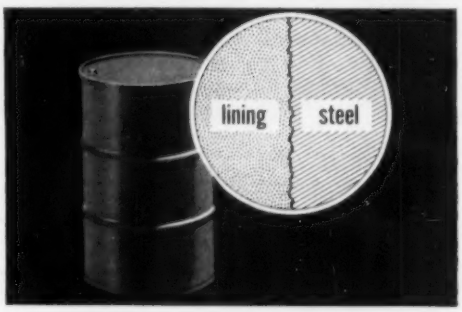
Rheem readies its steel drums for rough treatment 3 important ways



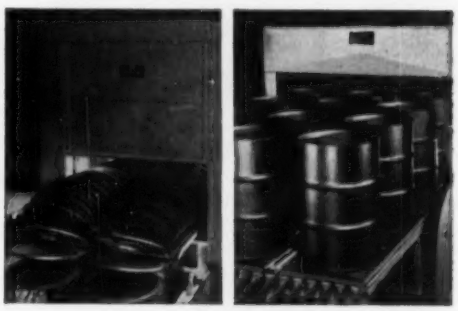
RHEEM **BLASTS** its drums under a hailstorm of high carbon steel chips. This physically cleans the surface, so protective linings and exterior coatings can get a lasting grip on roughened, naked steel—can stand up to miles of jarring blows and bounces.



RHEEM **BONDS** its drum linings directly to the steel. No scale or impurity is sandwiched between steel and lining to invite flaking or peeling, even under sudden temperature changes on the road. Rheem linings can't slip or slide . . . they're integrated!



RHEEM **BAKES** its drums in a *stand-up* oven for more even baking. Their tops and bottoms have a separate oven. It's fussy detail, but curing is a critical step in applying linings that *last*, and 2-oven baking does just that.

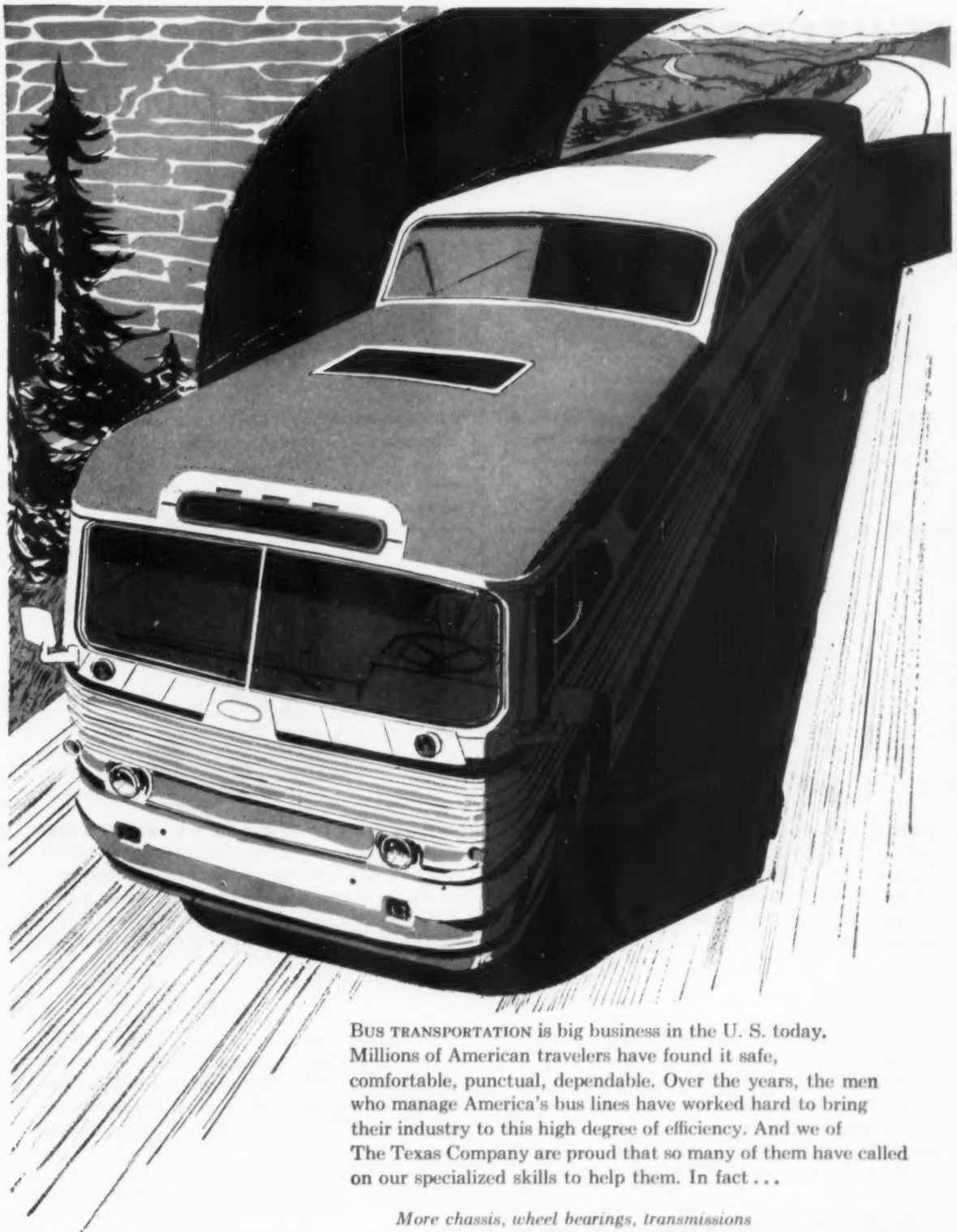


ONLY RHEEM DOES ALL THREE—TO PERFECT ITS PRODUCT—TO PROTECT YOURS

YOU CAN RELY ON
5001 Jefferson Hwy., P.O. Box 4027,
Carrollton Sta.,
New Orleans 18, La.
1025 Lockwood Dr., Houston 20, Tex.

Rheem

MANUFACTURING COMPANY
LEADING PRODUCER OF STEEL SHIPPING CONTAINERS
RICHMOND AND SOUTH GATE, CALIF., HOUSTON, CHICAGO, NEW YORK,
NEW ORLEANS, LINDEN, N.J., SPARROWS POINT, MARYLAND



BUS TRANSPORTATION is big business in the U. S. today. Millions of American travelers have found it safe, comfortable, punctual, dependable. Over the years, the men who manage America's bus lines have worked hard to bring their industry to this high degree of efficiency. And we of The Texas Company are proud that so many of them have called on our specialized skills to help them. In fact . . .

More chassis, wheel bearings, transmissions and differentials of buses in the United States are lubricated with Texaco Products than with any other brand.

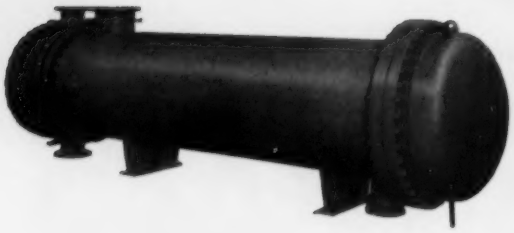
TEXACO

THE TEXAS COMPANY

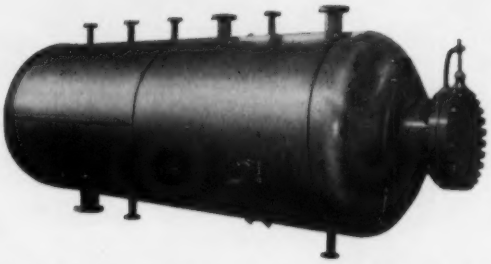
For more data on advertised products, use Readers' Service Cards, last page.

WHITLOCK PROCESS EQUIPMENT

. . . for every processing purpose!

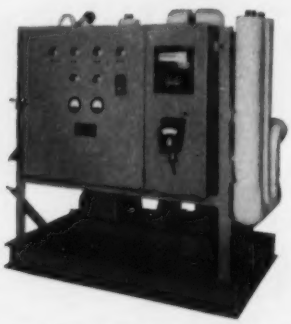


HEAT EXCHANGERS Whitlock manufactures a complete range of heat exchangers for every processing requirement. Standard designs include: Straight Tube and U-Tube, and Coil and Double Pipe types.



PRESSURE VESSELS Where engineering design is important — for special operating conditions, longer service, or lower maintenance costs — a Whitlock Engineer can help you select the right Pressure Vessel to meet your exact needs.

COILS Whitlock is fully equipped to fabricate coils of any size or material and to assemble and test them hydrostatically or by "air under water". Whether your process demands standard or special configurations, Whitlock can meet your requirements quickly and economically.



"PACKAGED" PROCESS SYSTEMS Whitlock is regularly "packaging" complete assemblies to handle typical process problems as in the case of this transfer oil heating system. Included are standard heat exchangers and vessels with complete operating controls for simple plant installation permitting immediate operation.

In addition to manufacturing standard sizes and types of Heat Exchangers, Whitlock is fully equipped to design and build specially constructed Exchangers for both high and low temperature services and for operating pressures ranging from a complete vacuum to several thousand pounds per square inch. Through long experience, Whitlock Engineers have developed special techniques for welding all standard materials as well as combinations of dissimilar metals such as aluminum to bronze and nickel to carbon steel. For complete information, write The Whitlock Manufacturing Company, 75 South Street, West Hartford 10, Connecticut. In Canada: Darling Brothers, Ltd., Montreal.

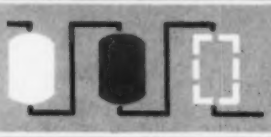
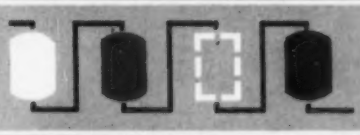
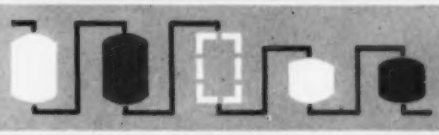
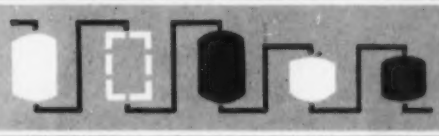
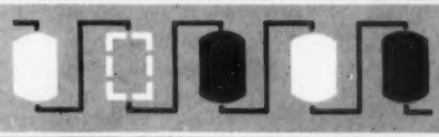
Whitlock

Designers and builders of bends, coils, condensers, coolers, heat exchangers, heaters, piping, pressure vessels, receivers, reboilers.

9 ways to demineralize water

(BY ION EXCHANGE)

KEY: Hydrogen Cation Unit — Removes metallic cations such as calcium, magnesium, sodium. Regenerated with sodium for simple water softening. Weakly Basic Anion Unit — Removes strongly ionized acids such as sulfuric, hydrochloric, nitric. Strongly Basic Anion Unit — Removes strongly ionized acids, also weakly ionized acids such as silicic and carbonic. Mixed Bed Unit —Contains both Hydrogen Cation and Strongly Basic Anion Exchangers, intimately mixed. Degasifier — Optional. Reduces load on Strongly Basic Anion Exchanger by removing free CO_2 brought in by raw water or developed in cation unit.

A	 Effluent Conductivity—10 to 20 micromhos (no silica reduction)	Uses low-cost anion exchanger and anion regenerant (soda ash). Typical use—removing soluble salts from water for ceramic mixes and slips or from rinse waters used before painting, mirror silvering, etc.
B	Effluent Conductivity—same as A. Silica content—0.02 to 0.15 ppm.	Used for treating feedwater for boilers in general range of 600 to 1400 psi. Also (without degasifier) for removing impurities from plating baths and recovering chromate from plating rinses.
C	 Same effluent as B.	For raw water with high sulfate and chloride content. Low-cost Weakly Basic Anion Exchanger removes major portion of electrolyte load. Countercurrent regeneration of anion units reduces operating costs.
D	 Effluent Conductivity—3 to 5 micromhos. Silica same as B.	For same type of raw water as C. Countercurrent regeneration of both cation and anion units cuts operation costs.
E	 Effluent Conductivity—1 to 5 micromhos. Silica same as B.	For waters where alkalinity is a major part of the anion content. Polishing units require infrequent regeneration. Produces, at low cost, low-solids feedwater suitable for high pressure boilers (over 1400 psi).
F	 Same effluent as E.	High flexibility of operation. Can operate in parallel for peak flows. Can maintain service flow during regeneration of either pair of units.
G	Effluent Conductivity—less than 1 micromho. Silica same as B.	Produces effluent of extremely high quality. Suitable for "super critical" pressure boilers and atomic reactors. (Initial and operating costs are usually higher than for separate anion and cation units.)
H	Same effluent as G.	For raw water with high sulfate and chloride content. Two-step demineralizer reduces load on Mixed Bed unit, cuts operating cost. (Strongly Basic Anion Exchanger is used in place of Weakly Basic where raw water has high silica and alkalinity.)
I	Same effluent as G.	Recommended where alkalinity of raw water is high. Cation unit and Degasifier reduce load on Mixed Bed unit, cut operating costs.

All of the above systems, with equipment and resins made by Permutit, are in commercial use. Other combinations are possible—also use of special ion exchangers such as PERMUTIT SK for separating uranium oxide from other metallic oxides in ore.

Most of these systems (C and higher) are used almost exclusively for demineralizing feedwater for high-pressure boilers . . . but the list of possible applications in other fields is growing.

If you have a problem ion exchange might solve, we'll be glad to study it with you and bring you the benefits of this experience. Address: The Permutit Company, Dept.PR-9, 330 West 42nd St., New York 36, N. Y.

PERMUTIT®

rhymes with "compute it"

ION EXCHANGE for Water Conditioning
Chemical Processing • Industrial Waste Treatment

For more data on advertised products, use Readers' Service Cards, last page.

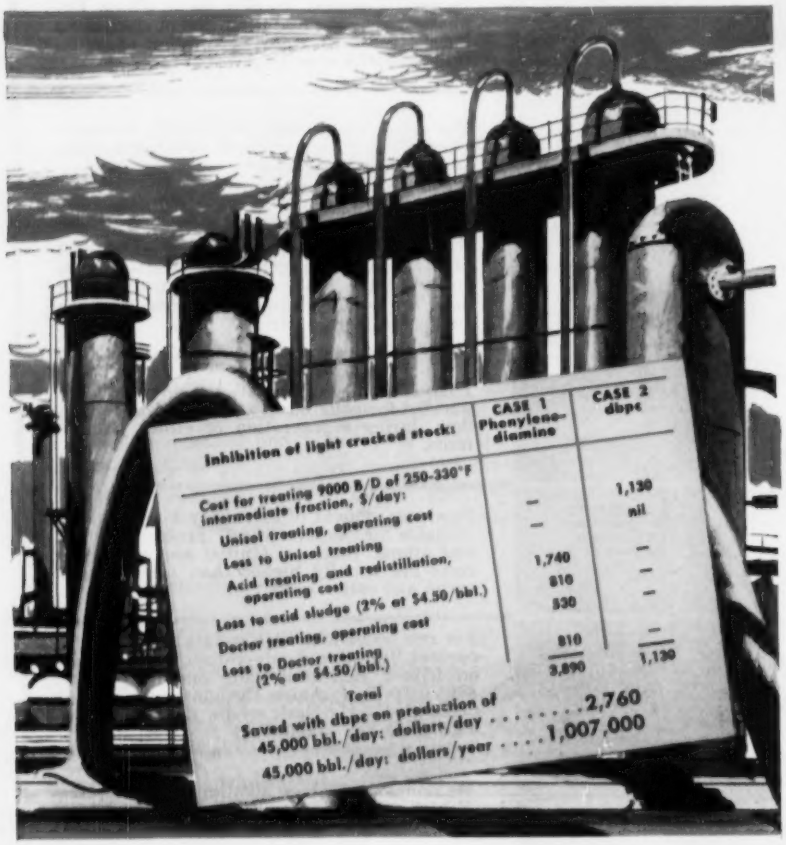
How oil refiner saves $1,000,000 with dbpc® antioxidant

(a quality chemical that Koppers makes)

dbpc antioxidant (di-tertiary-butyl-para-cresol) not only keeps auto engines clean, but *cuts the cost* of inhibiting gum formation. Here is how **dbpc** is saving one large refiner over $1,000,000 a year since switching to this quality Koppers antioxidant:

This refiner splits its full-range thermal cracked and catalytic cracked gasoline (FCC-TCC) streams into light and heavy fractions. The light portions have a high end point of 330° F.

Phenylenediamine formerly was used to inhibit the light cracked stocks. But with Unisol sweetening this inhibitor caused excessive "Lauson" and ISD type gum formation if the high end point was raised above 250° F. As a result, some of the light stocks, with end points from 250° to 330° F, had to be acid treated, redistilled, and doctor sweetened along with the heavy fractions. This was more expensive than Unisol sweetening, so the refiner looked for a way to treat the *entire* light fraction by Unisol sweetening.


Inhibition of light cracked stock:
CASE 1 Phenylene-diamine
CASE 2 dbpc
Cost for treating 9000 B/D of 250-330°F intermediate fraction, $/day:
Unisol treating, operating cost
Loss to Unisol treating
Acid treating and redistillation, operating cost
Loss to acid sludge (2% at $4.50/bbl.)
Doctor treating, operating cost
Loss to Doctor treating (2% at $4.50/bbl.)
1,130
nil
1,740
810
530
810
3,890
1,130
Total
Saved with dbpc on production of 45,000 bbl./day: dollars/day 2,760
45,000 bbl./day: dollars/year 1,007,000

dbpc antioxidant solved this problem. With this inhibitor, a high end point of 330° F is perfectly satisfactory for the light fraction. No trouble with gum has developed. Inhibition costs about the same as before. But ultimate costs have been drastically reduced—over $1,000,000 a year, figuring an average production of 45,000 barrels a day. This giant saving was realized by eliminating the expensive acid treating, redistillation, and doctor sweetening of the 250° to 330°F fraction.

Remember, you get more effective inhibition with Koppers **dbpc** because you add it *early* in the refining process before much oxidation occurs — and none of the **dbpc** is lost in later refining steps. Leaded or unleaded gasoline treated with **dbpc** will not darken or discolor. **dbpc** does not induce tank sweetening. It is not extracted by aqueous corrosion inhibitors. Most important—it can save you money. Write for full technical details, or get in touch with the nearest Koppers Sales Office. Koppers Company, Inc., Chemical Division, Dept. PR-96, Pittsburgh 19, Pennsylvania.

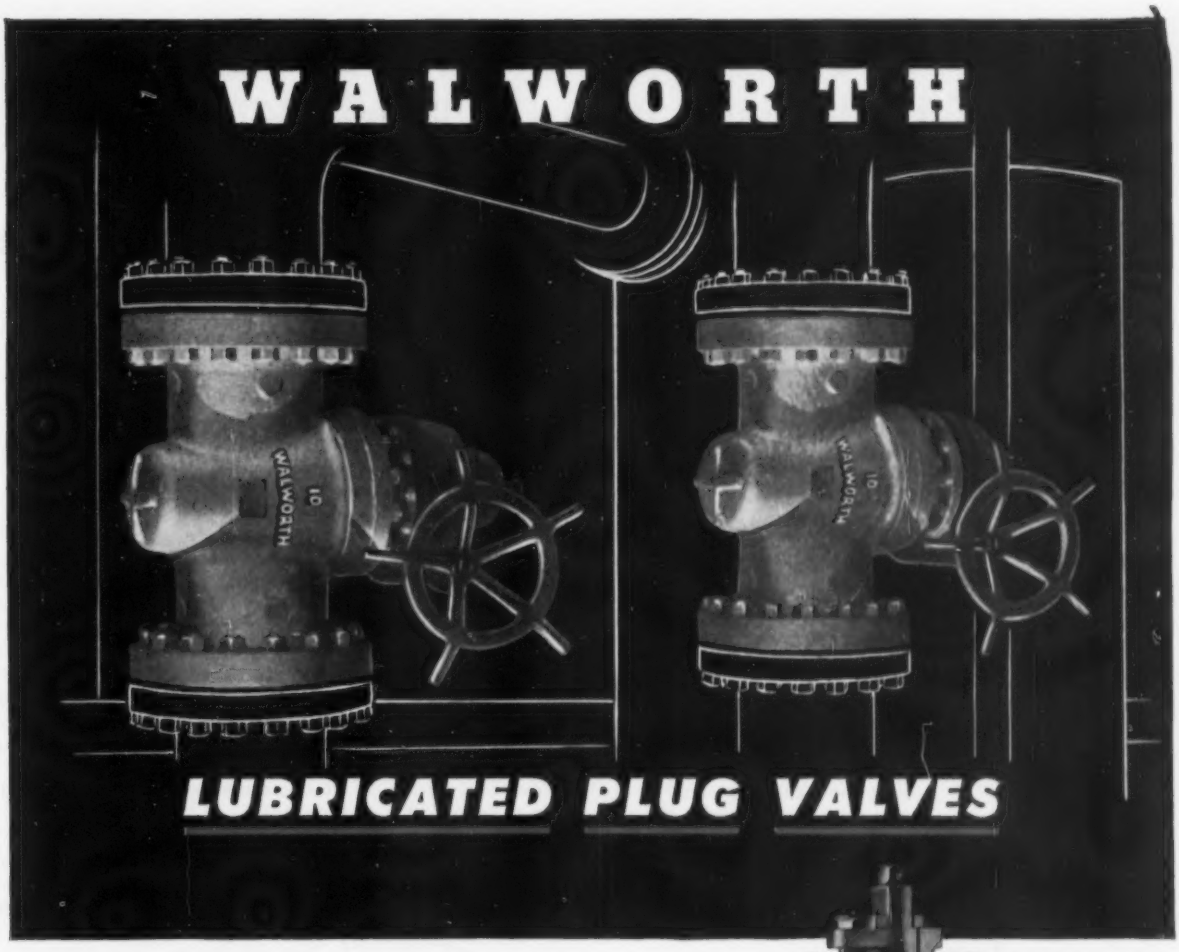
KOPPERS

KOPPERS CHEMICALS

SALES OFFICES: New York • Boston • Philadelphia • Atlanta • Houston • Chicago • Detroit • Los Angeles • San Francisco

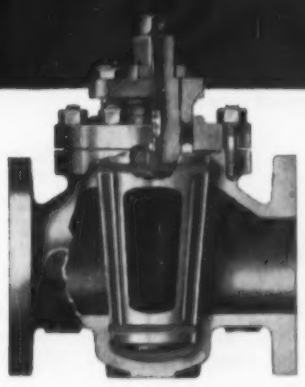
In Canada: Dominion Anilines and Chemicals Ltd., Toronto, Ontario

WALWORTH



LUBRICATED PLUG VALVES

Better because ... **They are pressure sealed with an insoluble lubricant readily renewed while the valve is in service. Lubricant completely surrounds the plug ports assuring a tight seal against leaks. It also insures ease of operation by reducing friction between the body and the plug while at the same time protecting the finished surfaces against corrosion and wear.**



Lubricant system of a Walworth No. 1700F Regular Gland, Wrench Operated, Steel-iron, *Lubricated Plug* Valve. Other Walworth *Lubricated Plug* Valves include Single Gland, and Ball Bearing types. Sizes to 30-inches — pressures to 5,000 psi, and for vacuum service.

Walworth Lubricated Plug Valves are the most satisfactory valves available for the handling of gritty suspensions, and many other destructive, erosive, and corrosive industrial and chemical solutions.

They are ideal for general refinery and pipeline service.

For full information see your Walworth Distributor, or write for your copy of Bulletin 111. Walworth Company, General Offices, 60 East 42nd Street, New York 17, N. Y.

WALWORTH

Manufacturers since 1842

valves . . . pipe fittings . . . pipe wrenches

60 East 42nd Street, New York 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

For more data on advertised products, use Readers' Service Cards, last page.

Johns-Manville organizes to give you better insulation service

New and separate insulations division created to provide industry greatly improved Sales and Engineering service to meet modern problems

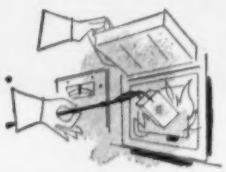
• Johns-Manville is now concentrating all industrial insulation operations within a new, fully integrated insulations division. This greater specialization makes possible the most complete insulation service available to industry. It consists of—

Sales Representatives . . . men on whom you can rely for your insulation recommendations. Your J-M salesman will help you select the insulating material exactly right for your job—the one that will provide maximum fuel savings, improved process control, and minimum maintenance. As co-ordinator of J-M's extensive research-engineering-manufacturing facilities, he offers you outstanding insulation training and experience.

Insulation Engineers—Backing up the J-M salesman on every job is the J-M insulation engineer. He is primarily concerned with solving insulation problems. He recommends the economic thickness of insulation, as well as the proper finishes, weatherproofing and securement. His highly specialized knowledge makes possible an intelligent recognition and handling of your individual insulation requirements.

Insulation Contract Units . . . Fully aware that no insulation is better than the man who applies it, the J-M Insulation Contractor makes care and skill in the scientific application of Johns-Manville insulations his stock in trade. He maintains a complete crew of estimators and mechanics trained in J-M application techniques. He is ready to give you fast, efficient service on any insulation job—large or small. Proud of his reputation for integrity in his own community, the J-M Insulation Contractor merits your complete confidence.

Complete Range of Products—In this day of exacting temperature control, the need for specific insulations for specific services is greater than ever before. Recognizing this, Johns-Manville manufactures insulations for every industrial requirement. Produced from the finest grades of asbestos, magnesium carbonate, diatomaceous silica, refractory clays and ceramic fibers, they are designed to afford maximum insulating effectiveness and durability at operating temperatures ranging from minus 300F to plus 3000F.



Extensive Research Facilities—At Manville, New Jersey, Johns-Manville maintains the world's most completely equipped insulation laboratory. Here insulation scientists are engaged in a continuous program of developing new and better insulating materials. In addition, their technical knowledge is always available to J-M customers whose insulation problems require special study.

Experienced Management—At headquarters as well as in the field, management of the new insulations division consists of men who, in line with J-M's promotion-from-within policy, are insulation veterans. With a realistic grasp of customers' needs, they are alert to new and better ways to serve you . . . now, and in the future.

On Your Next Insulation Job—Whether your next insulation job is big or little, simple or complex, let Johns-Manville handle it for you. Just call your nearest J-M sales office, or write direct to Johns-Manville, Box 14, New York 16, New York. In Canada, Port Credit, Ontario: *Chances are, you'll be glad you did!*

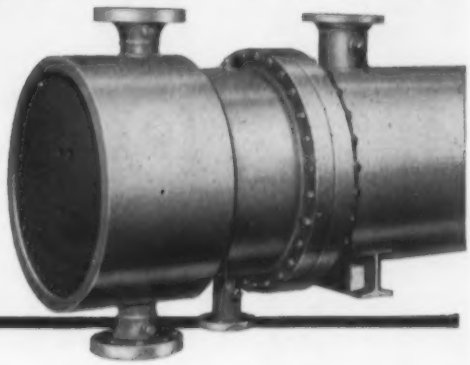
Johns-Manville *first-in* **INSULATION**

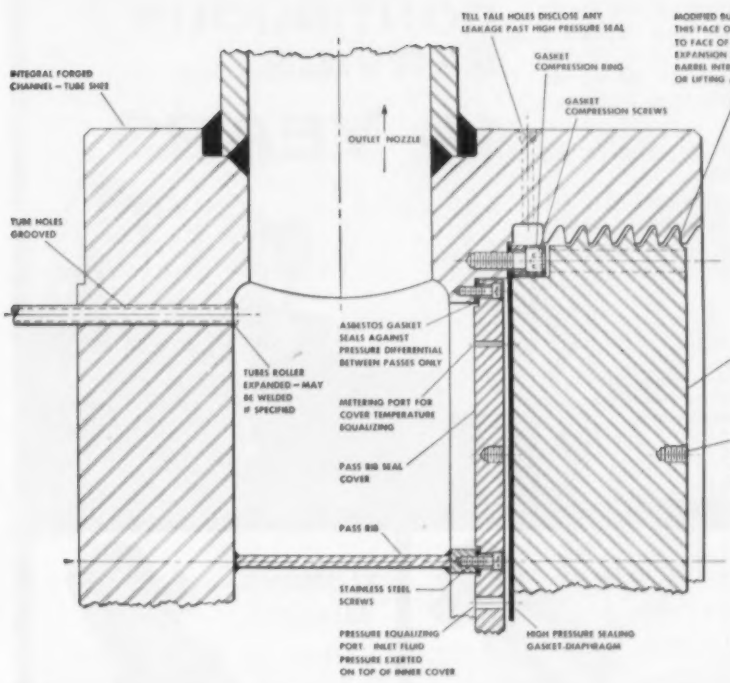
MATERIALS · ENGINEERING · APPLICATION

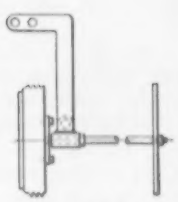
INSIDE FACTS

on the simplicity, safety and operating advantages of the exclusive Ross High Pressure Closure Design*

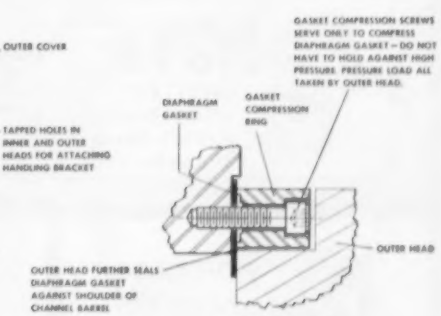
- Simpler design.
- Fewer parts to handle.
- High pressure seal unaffected by hydrostatic loads.
- Greater safety factor.
- Sudden load fluctuations no problem.
- Outer cover cannot corrode and bind . . . easily removed.
- Easily opened for inspection.




TELL TALE HOLES DISCLOSE ANY LEAKAGE PAST HIGH PRESSURE SEAL
MODIFIED BUTTRESS THREAD. THIS FACE OF THREAD PARALLEL TO FACE OF HEAD. DIFFERENTIAL EXPANSION BETWEEN HEAD AND BARREL INTRODUCES NO WEDGING OR LIFTING ACTION IN HEAD
GASKET COMPRESSION RING
GASKET COMPRESSION SCREWS
INTEGRAL FORGED CHANNEL – TUBE SHEET
OUTLET NOZZLE
TUBE HOLES GROOVED
ASBESTOS GASKET SEALS AGAINST PRESSURE DIFFERENTIAL BETWEEN PASSES ONLY
TUBES ROLLER EXPANDED – MAY BE WELDED IF SPECIFIED
METERING PORT FOR COVER TEMPERATURE EQUALIZING
OUTER COVER
TAPPED HOLES IN INNER AND OUTER HEADS FOR ATTACHING HANDLING BRACKET
PASS RIB SEAL COVER
PASS RIB
STAINLESS STEEL SCREWS
PRESSURE EQUALIZING PORT. INLET FLUID PRESSURE EXERTED ON TOP OF INNER COVER
HIGH PRESSURE SEALING GASKET-DIAPHRAGM



TYPICAL COVER HANDLING BRACKET FOR HORIZONTAL UNIT


GASKET COMPRESSION SCREWS SERVE ONLY TO COMPRESS DIAPHRAGM GASKET – DO NOT HAVE TO HOLD AGAINST HIGH PRESSURE PRESSURE LOAD ALL TAKEN BY OUTER HEAD.
DIAPHRAGM GASKET
GASKET COMPRESSION RING
OUTER HEAD
OUTER HEAD FURTHER SEALS DIAPHRAGM GASKET AGAINST SHOULDER OF CHANNEL BARREL

DETAIL OF GASKET COMPRESSION RING FACING

NOW FOR ALL THE DETAILS,

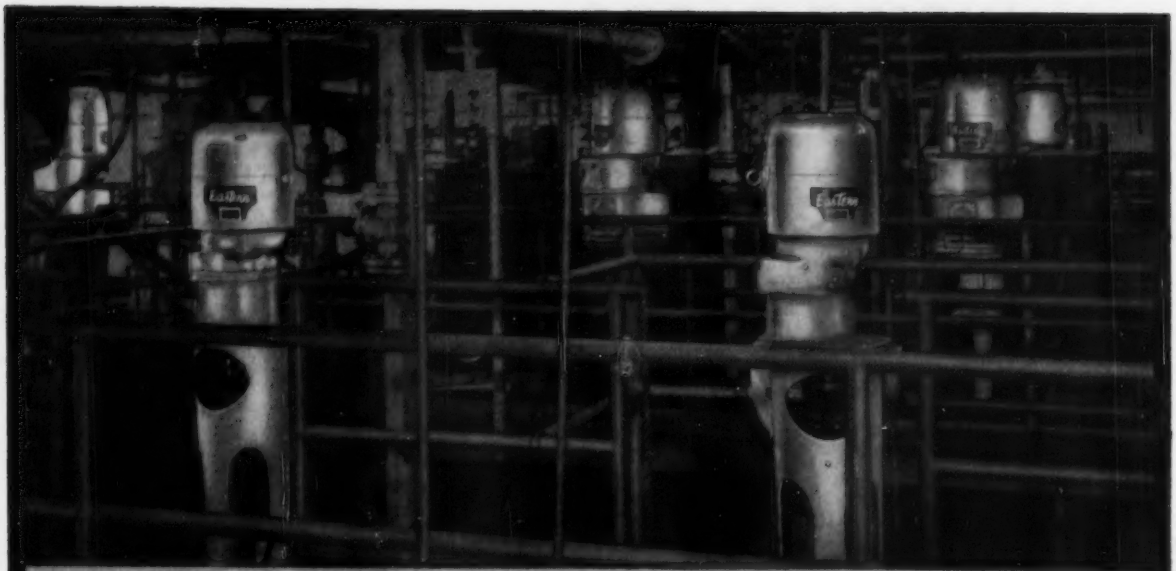
request new Bulletin 5.6K1, mailed immediately. Write Ross Heat Exchanger Division of American-Standard, Buffalo 5, N. Y. In Canada: Kewanee-Ross of Canada Limited, Toronto 5, Ont.

ROSS

ROSS HEAT EXCHANGER PRODUCTS

*for feedwater heaters and other high pressure, high temperature exchangers

For more data on advertised products, use Readers' Service Cards, last page.



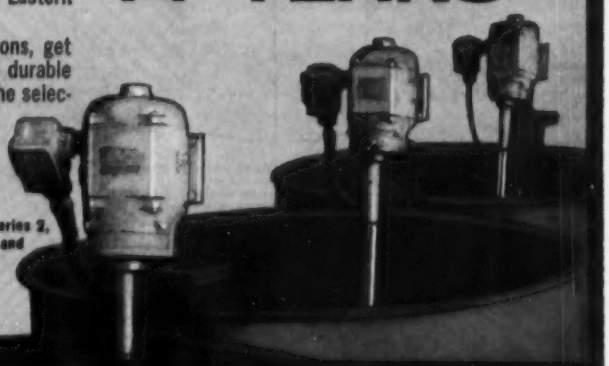
Back in 1942 the new synthetic rubber program was of urgent importance to the war effort. Naugatuck Chemical Co., now a Division of U.S. Rubber Co., developed processes that included fluid mixing applications. Many of Naugatuck's top-entering and portable mixers were engineered and manufactured by Eastern Industries specifically for these processes.

After fourteen years of hard, continuous service, these Eastern Mixers continue proving their built-in **reliability.**

If you have a process entailing critical operating conditions, get a long-term guarantee on your investment by selecting durable Eastern Mixers. Eastern offers engineering assistance in the selection of proper mixers from the complete Eastern line.

CONTINUOUS SERVICE . . .

14 YEARS



Eastern

INDUSTRIES, INC.
Mixer Division
Regent Street
Norwalk, Conn.

Write for Catalog Series 2, containing product and engineering data.

PORTABLE MIXERS

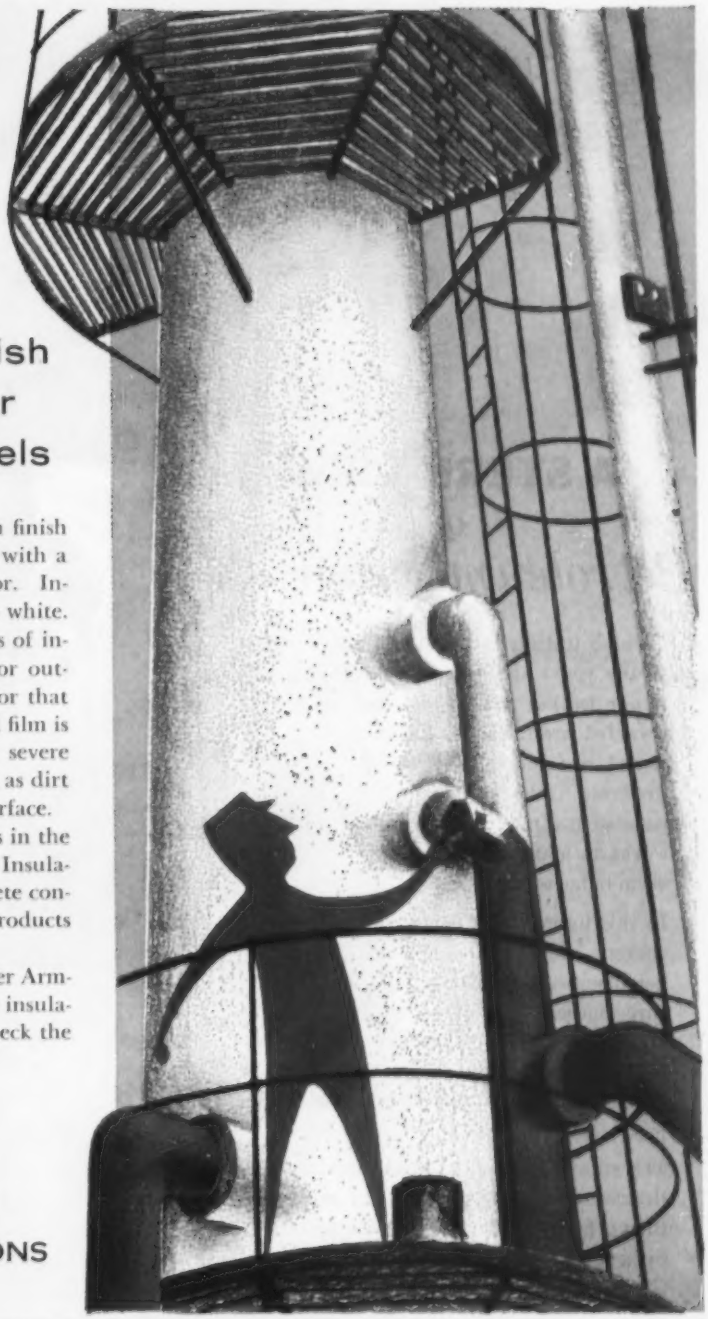
Various models offer a choice of speeds and H.P. dependent upon the consistencies of fluids. All models are available with shafts and propellers of various alloys. Single and dual propellers, and a wide choice of motors give flexibility to handle the most critical of operating conditions.

TOP & SIDE ENTERING MIXERS

Heavy-duty models cover the range from ¼ to 30 H.P., at speeds from 280 to 1725 R.P.M. Versatile in design . . . rugged in performance, these mixers offer a wide choice in mounting arrangements and motors. All side entering models are available with stuffing boxes which can be repacked with a full tank.

TURBINE MIXERS

Many of the Eastern Turbine applications include blending, dissolving and heat transfer. A variety of motor mounts and stuffing boxes available within a H.P. range of ¼ to 40, add flexibility to the Eastern line.



Rugged insulation finish for indoor and outdoor lines, tanks, and vessels

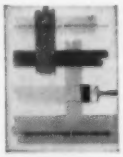
Reduce insulation costs by providing both finish and color identification at the same time with a protective coating of Armstrong Insulcolor. Insulcolor comes in seven colors, plus a clean white. It is applied by brush or spray to all types of insulated lines, tanks, and vessels, indoors or outdoors. There are no solvents in Insulcolor that create a hazard during application. Dried film is fire-resistant, and lasts for years under severe weather conditions. Maintenance is easy, as dirt washes readily from Insulcolor's smooth surface.

Insulcolor is one of the quality products in the complete line of Armstrong Industrial Insulations. Armstrong also offers you a complete contracting service, geared to install these products economically and efficiently.

For full details on Insulcolor or any other Armstrong materials that may help solve your insulation problems, send for free booklets. Check the ones you want on the coupon below.

Armstrong

INDUSTRIAL INSULATIONS



☐ Armstrong Insulcolor®, Weatherproof Coating in Seven Colors

☐ Armstrong LT Cork Covering, a New Type Cold Line Insulation

☐ Armstrong Armaglas Insulations for Pipes, Tanks, and Vessels

☐ Armstrong Armaflex*, a New Flexible Insulation for Piping

*TRADE-MARK

Armstrong Cork Company
2509 Ream Ave.
Lancaster, Pa.

Please send me the free booklets checked. ☐

Please have an Armstrong representative call. ☐

Name .....

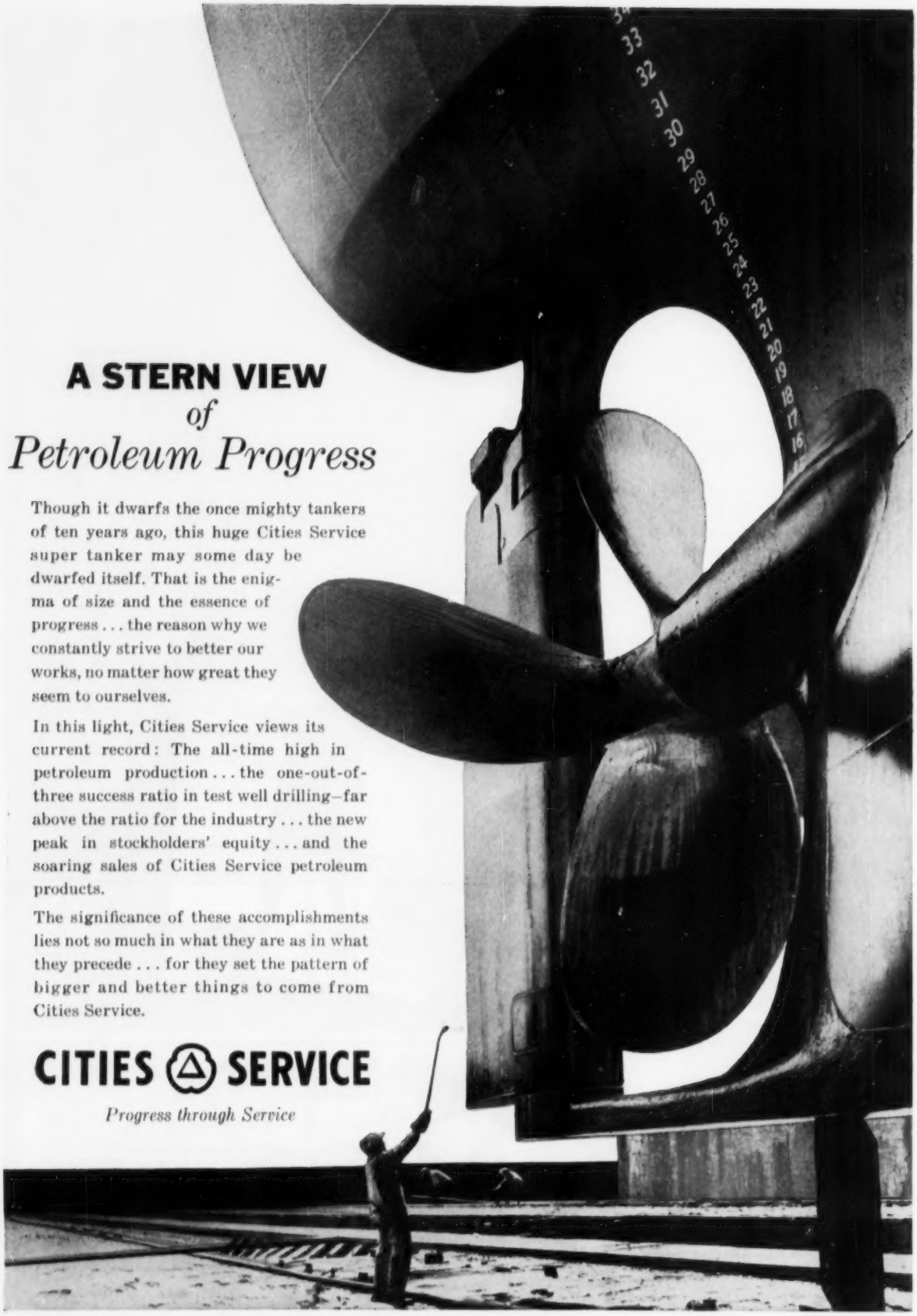
Position .....

Company .....

Address .....

City ..... Zone .... State .....

For more data on advertised products, use Readers' Service Cards, last page.



A STERN VIEW
of
Petroleum Progress

Though it dwarfs the once mighty tankers of ten years ago, this huge Cities Service super tanker may some day be dwarfed itself. That is the enigma of size and the essence of progress . . . the reason why we constantly strive to better our works, no matter how great they seem to ourselves.

In this light, Cities Service views its current record: The all-time high in petroleum production . . . the one-out-of-three success ratio in test well drilling—far above the ratio for the industry . . . the new peak in stockholders' equity . . . and the soaring sales of Cities Service petroleum products.

The significance of these accomplishments lies not so much in what they are as in what they precede . . . for they set the pattern of bigger and better things to come from Cities Service.

CITIES SERVICE

Progress through Service

insulation ECONOMICS

Both designer and accountant can have their way. CAPOSITE is the finest insulating material. It is also the most economical.
Compare the points in its favour with those of any other insulating material: maximum efficiency up to 1000°F. without protection; light weight; mechanical strength—above 1000°F. combined with "Caposil" High Temperature insulating material, all these characteristics are retained. CAPOSITE is cheap, quick and clean to fit, and can be applied to cold surfaces. It is permanent, stays rigid—and never sags. Take these features together, and you have the thermal insulation with the *Highest Efficiency* and the

Lowest Annual Charge *

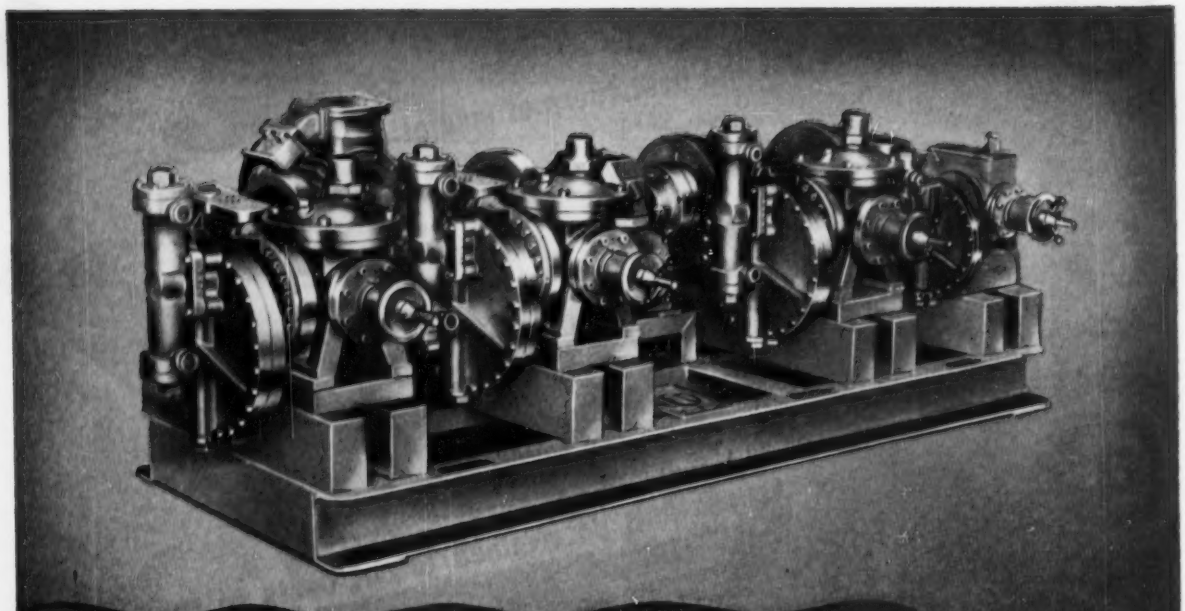
CAPOSITE REGD

Amosite Asbestos Blocks and Pipe Sections

** annual heat loss value plus financial depreciation*

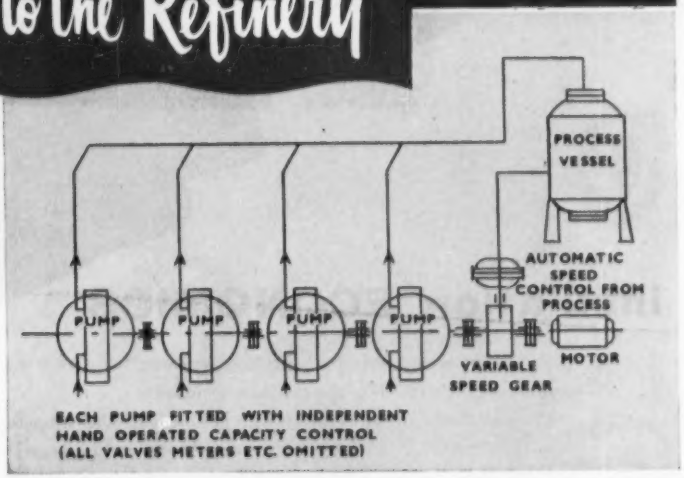
CAPE

THE CAPE ASBESTOS COMPANY LIMITED, 114 & 116 Park Street, London, W.1. *GROsvenor 6022*
Canadian Enquiries: CAPE ASBESTOS (CANADA) LTD., 200 Bloor Street East, Toronto, Ontario
United States Enquiries: NORTH AMERICAN ASBESTOS CORP., Board of Trade Building, Chicago 4, Illinois



Automation comes to the Refinery

The above photograph illustrates an assembly of four hydraulically operated piston diaphragm pumps of various capacities, each fitted with micro capacity control.



The pumps are driven by one motor through a variable speed hydraulic gear box fitted with standard pneumatic diaphragm head connected to the control so that the speed of the complete unit can be varied from zero to full by a signal pressure from 3 to 15lb. per square inch. This in conjuction with the individual capacity control on each pump enables the rate of delivery of any mixture to be automatically controlled from the process plant.

E.C.D LTD TONBRIDGE · KENT

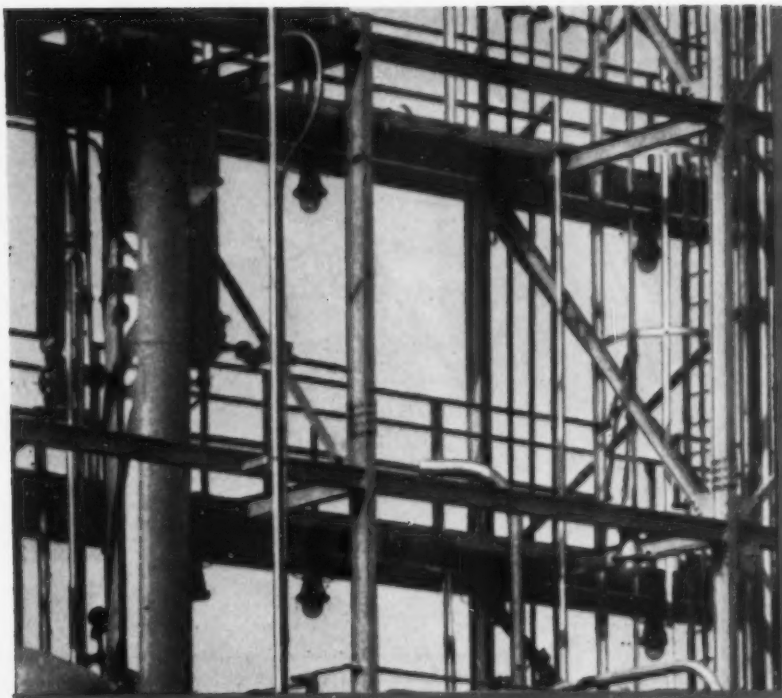
E.C.D. LIMITED · ENGINEERS

TONBRIDGE · KENT · ENGLAND

Telephone : Tonbridge 2237 (3 lines)

Telegrams : Tonmil, Tonbridge.

For more data on advertised products, use Readers' Service Cards, last page.



Towns Gas

Synthesis Gas

Girbotol Plants

Reforming Plants

Sulphuric Acid
and Sulphur Recovery

Catalytic and non-catalytic
Oil Gas Processes

Pease-Anthony Scrubbers

Plant and Equipment

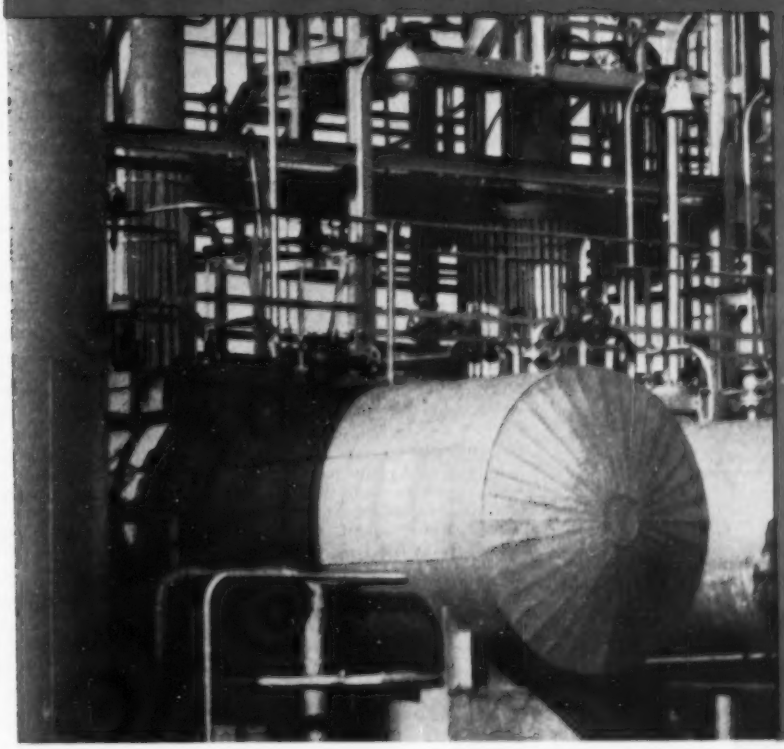


Plate Fabrication

Pressure Vessels

Floating Roofs

Radiography

Gasholders

Pipe Work

Heat Exchangers

Meehanite
Castings

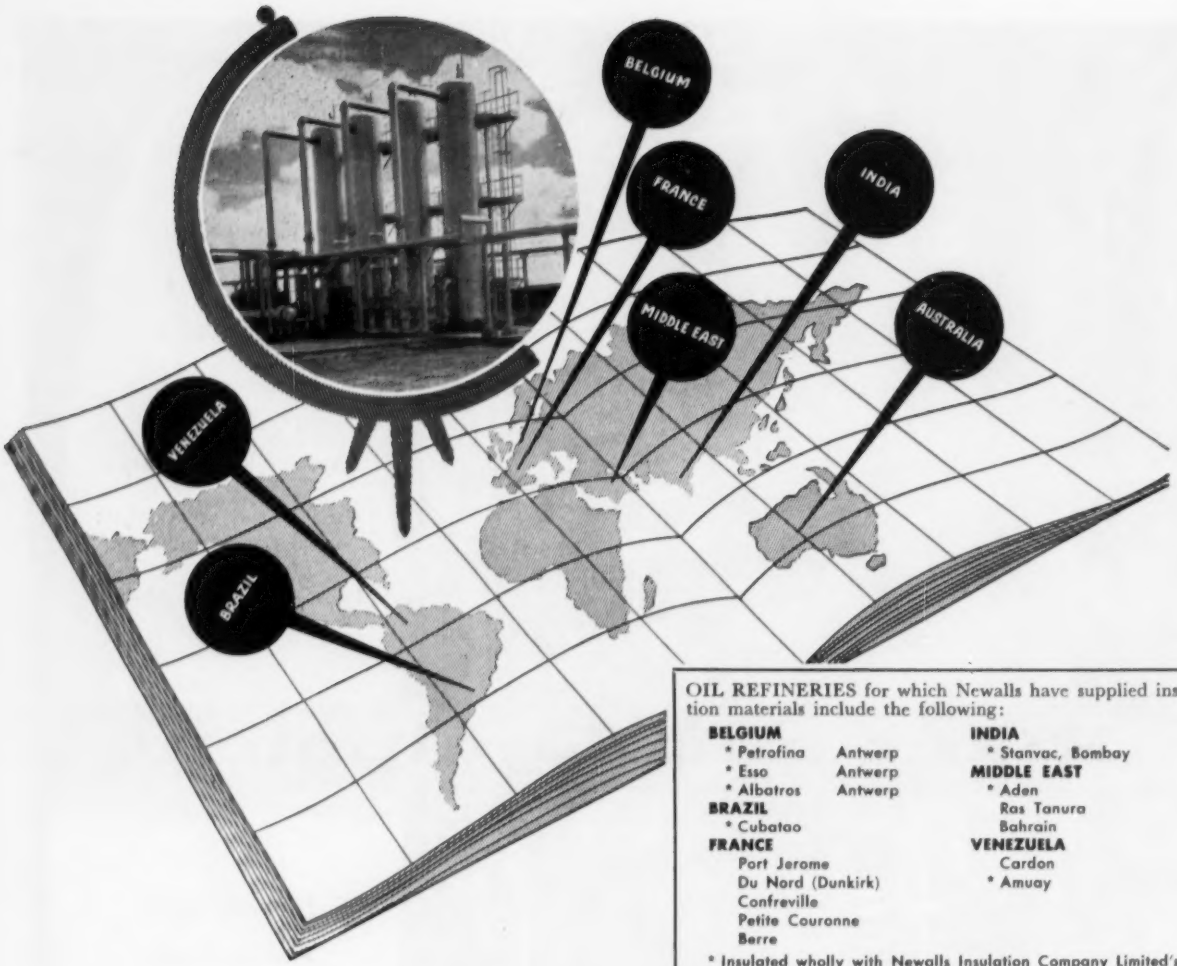
THE POWER · GAS CORPORATION LIMITED

AND

ASHMORE, BENSON, PEASE & COMPANY

STOCKTON-ON-TEES AND LONDON

276 AUSTRALIA · CANADA · INDIA · FRANCE · SOUTH AFRICA



OIL REFINERIES for which Newalls have supplied insulation materials include the following:

BELGIUM
- * Petrofina — Antwerp
- * Esso — Antwerp
- * Albatros — Antwerp

BRAZIL
- * Cubatao

FRANCE
- Port Jerome
- Du Nord (Dunkirk)
- Confreville
- Petite Couronne
- Berre

INDIA
- * Stanvac, Bombay

MIDDLE EAST
- * Aden
- Ras Tanura
- Bahrain

VENEZUELA
- Cardon
- * Amuay

* Insulated wholly with Newalls Insulation Company Limited's materials.

Since the turn of the century Newalls have built up a world-wide reputation for efficient insulation of all types of industrial and marine projects.

To the rapid expansion of the oil industry during the past two decades, Newalls were able to bring a wealth of experience and the benefit of proved insulation techniques from other fields, contributing greatly to effective temperature control and new peaks of operating efficiency in oil refinery work.

Newalls provide an international contracting organisation equipped to handle insulation treatment on refineries in all world markets with their well-known range of time-proved materials, including Newalls (Regd. Brand). 85% Magnesia, Nicosil, Newtempheit, and Amosite Asbestos products to meet temperatures from —300° F. up to over 2,000° F.

Newalls Technical Advisory Service will assist on all insulation matters from plant conception to installation. We invite you to take advantage of our comprehensive service.

At home and abroad
50 years
of insulation efficiency

Newalls

NEWALLS INSULATION CO., LTD.

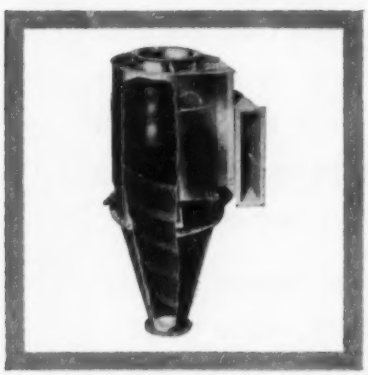
NEWALLS INSULATION CO., LTD. *Head Office: WASHINGTON, CO. DURHAM*

A member of the TURNER & NEWALL ORGANISATION

Agents and Vendors in most markets abroad

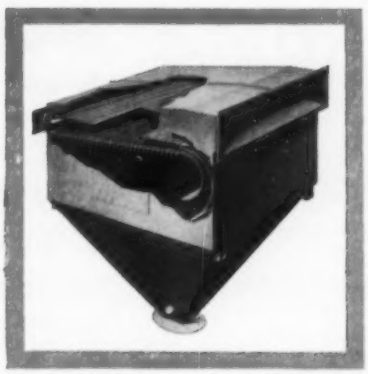
How Buell's Exclusive Rapping Mechanism delivers Extra Dust Collection Efficiency

ORDINARY RAPPING
Shakes dust from collecting electrodes. Re-entrainment of cloud of dust reduces precipitator efficiency
BUELL RAPPING
Shears dust from collecting electrode surface, minimizes scattering and re-entrainment



Buell Cyclones offer two "extra-efficiency" advantages: (1) exclusive Shave-off which harnesses double-eddy and puts it to work, and (2), large diameter design which eliminates clogging.

Complementing the extra efficiency of rapping in Buell "SF" Electric Precipitators, the unique Spiralectrodes add further efficiency through 50% to 100% higher electron emission, constantly accurate spacing, longer electrode life.



Buell's Low Resistance Fly Ash Collector combines top efficiency with low draft loss, for natural or forced draft installations. Ideal for boilers from 100 to 2000 BHP.

For more specific data about Buell's *extra efficiency*, write Dept. 21-I, Buell Engineering Company, 70 Pine Street, New York 5, N. Y.

buell®

MECHANICAL ELECTRICAL

Experts at delivering Extra Efficiency in **DUST COLLECTION SYSTEMS**

Here's the pitch on dependable WELDING FITTINGS

Welding fittings from J&L Supply are guaranteed accurate within A S A tolerances. Cut your pipe with confidence!

- Store stocks for your pick-up requirements.
- More comprehensive stocks centrally located and promptly available.
- On special specifications, direct factory shipment from the most versatile plants in America — welding fittings engineered to enable you to improve piping designs and reduce costs.

The line includes fittings of easy-to-weld JALTEN, made by J&L. Ideal for use with high-tensile, high-yield pipe.

Jones & Laughlin

SUPPLY DIVISION – Tulsa

SERVING THE UNITED STATES AND CANADA

7-GA

For You

Catalyst "Know-How"

What makes one catalyst superior to another? Often it is the unseen ingredient, "know-how". Davison's long experience in successful catalyst production gives you this all-important element.

Davison, the first commercial producer of synthetic petroleum cracking catalysts, operates a modern plant for the sole purpose of producing specialty catalysts to aid industrial chemical progress. These catalysts can be custom made to your specifications. We guard your "know-how" as carefully as we do our own. They are made in many forms including granular, pelleted, powdered, spherical, extruded and include many supports and active agents.

Put Davison's "know-how" to work on your problem. No matter what your catalyst requirements are, it will pay you to discuss them with the Davison Field Service Engineer. A free booklet on Davison dependable catalysts is available on request.

DAVISON CHEMICAL COMPANY

Division of W. R. Grace & Co.

Baltimore 3, Maryland

Sales Offices: Chicago, Illinois; Houston, Texas; New York, New York; Baltimore, Maryland

In Canada: Davison Chemical Company Ltd., Toronto

Producers of: Catalysts, Inorganic Acids, Superphosphates, Triple Superphosphates, Phosphate Rock, Silica Gels and Silicofluorides. Sole Producers of DAVCO® Granulated Fertilizer.

For more data on advertised products, use Readers' Service Cards, last page.

HERE'S WHAT TO LOOK FOR IN REFRACTORY CASTABLES... and WALSH has them all...

(thanks to better research and ceramic engineering)

Demonstrating application of Walsh iron-free castable. Note low rebound loss, excellent nozzle compaction and remarkable trowel finish.

PHOTO PERMISSION REFRACTALL MFG. CO.

- **Uniform grain sizing assuring homogeneous structure for greater strength . . . better bond . . . throughout complete temperature range.**
- **Maximum resistance to abrasion.**
- **Excellent nozzle compaction—smooth trowel finish—low rebound loss.**
- **Highest modulus of rupture without sacrificing low "K" factor . . . wanted feature in light weight castables.**

These and many other advantages add up to performance characteristics that make Walsh Castables an investment in greater production . . . lower cost.

THEY'RE HOMOGENIZED

INSULATING CASTABLES

Lite-Wate Castable No. 50 . . . weight, dry, in place, 50 lbs. per cu. ft. Temp. range 2000° F.

Lite-Wate Castable No. 70 . . . weight, dry, in place, 70 lbs. per cu. ft. Temp. range 2100° F.

SERVICE CASTABLES

H & B Castable . . . weight, dry, in place, 105 lbs. per cu. ft. Temp. range 2700° F.

Super Castable No. 32 . . . weight, dry, in place, 115 lbs. per cu. ft. Temp. range 3000° F.

Something New Has Been Added! Now **Walsh Lite-Wate Insulating Castable No. 50 NISF** and **Super Castable No. 32** are "iron free" . . . contain less than 1% iron content. For details, consult your nearest Walsh distributor or write direct.

WALSH REFRACTORIES CORPORATION — America's Best Clays

WALSH REFRACTORIES CORPORATION

101 FERRY STREET • ST. LOUIS 7, MISSOURI

FOR OVER 60 YEARS MANUFACTURERS OF HIGH GRADE REFRACTORIES

SERVING THE
PETROLEUM
NATURAL GAS
CHEMICAL
AND ALLIED
INDUSTRIES

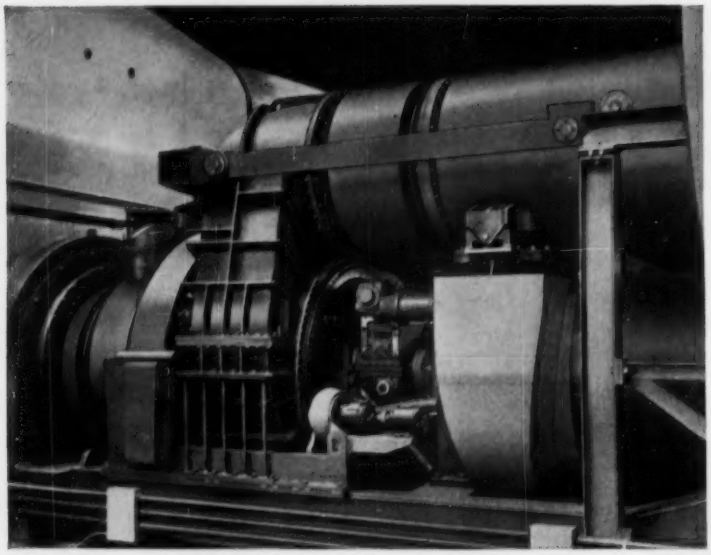
WYATT C. HEDRICK ENGINEERING CORPORATION

HOUSTON, TEXAS

CONSULTATION, PROCESS AND DEVELOPMENT ENGINEERING, SURVEYS AND ECONOMIC STUDIES ARE A PART OF OUR BROAD ENGINEERING SCOPE.

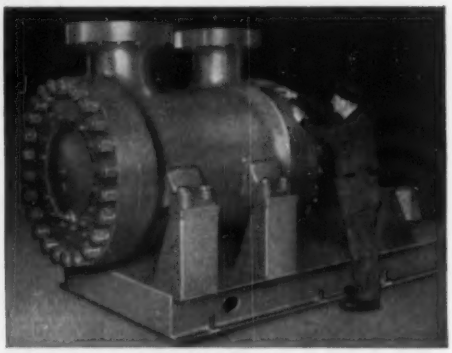
DETERMINATION OF THE REQUIREMENTS FOR RAW MATERIALS, UTILITIES AND PLANT INVESTMENT PLUS AN EXTENDED FORECAST OF EARNINGS WHICH PROPERLY RELATES THESE ITEMS IS NECESSARY FOR A REALISTIC RE-EVALUATION OF YOUR INTEREST IN ANY PROCESS.

For more data on advertised products, use Readers' Service Cards, last page.

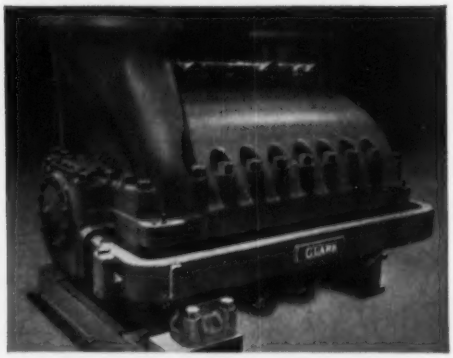


Clark 8500 BHP Gas Turbine for centrifugal compressor, generator or pump drive.

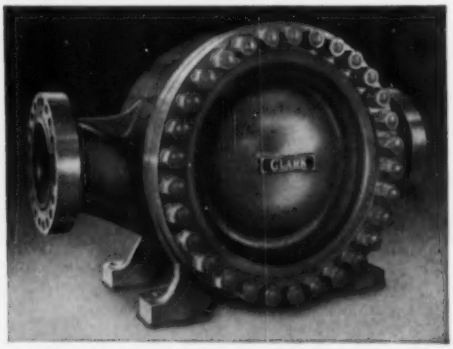
Clark Barrel Type Centrifugal Compressors for extremely high pressures.



Clark Multi-Stage Centrifugal Compressors designed for process applications.



Clark Centrifugal Pipeline Booster for low ratios and high pressures.



GAS TURBINES + CENTRIFUGAL COMPRESSORS

Only CLARK builds both!

Now you can get centrifugal compressors and modern gas turbines to drive them *exclusively* from one manufacturer . . . Clark.

In addition to saving money and headaches, you'll get proved, matched-performance "packages" specifically designed for continuous trouble free service.

Whether you have a million or a billion cubic feet of air or gas per day to handle at pressures of up to 4500 pounds per square inch, there is a Clark centrifugal compressor and in most cases a matching Clark gas turbine to drive it.

Your nearest Clark representative will be pleased to give you all the facts.

CLARK BROS. CO., OLEAN, N. Y.

One of the Dresser Industries

Offices in Principal Cities throughout the World

CLARK®

GAS TURBINES
CENTRIFUGAL COMPRESSORS

For more data on advertised products, use Readers' Service Cards, last page.

Averaged 16⅔ cubic yards an hour, for 8 hours, with 24 location changes!

ONE SHERMAN POWER DIGGER averaged 16⅔ cubic yards of excavation an hour, for 8 hours, for a southwestern plumbing contractor. And this figure included time necessary for 24 location changes! The Sherman is used, primarily, for digging water, gas and electrical service lines for new homes.

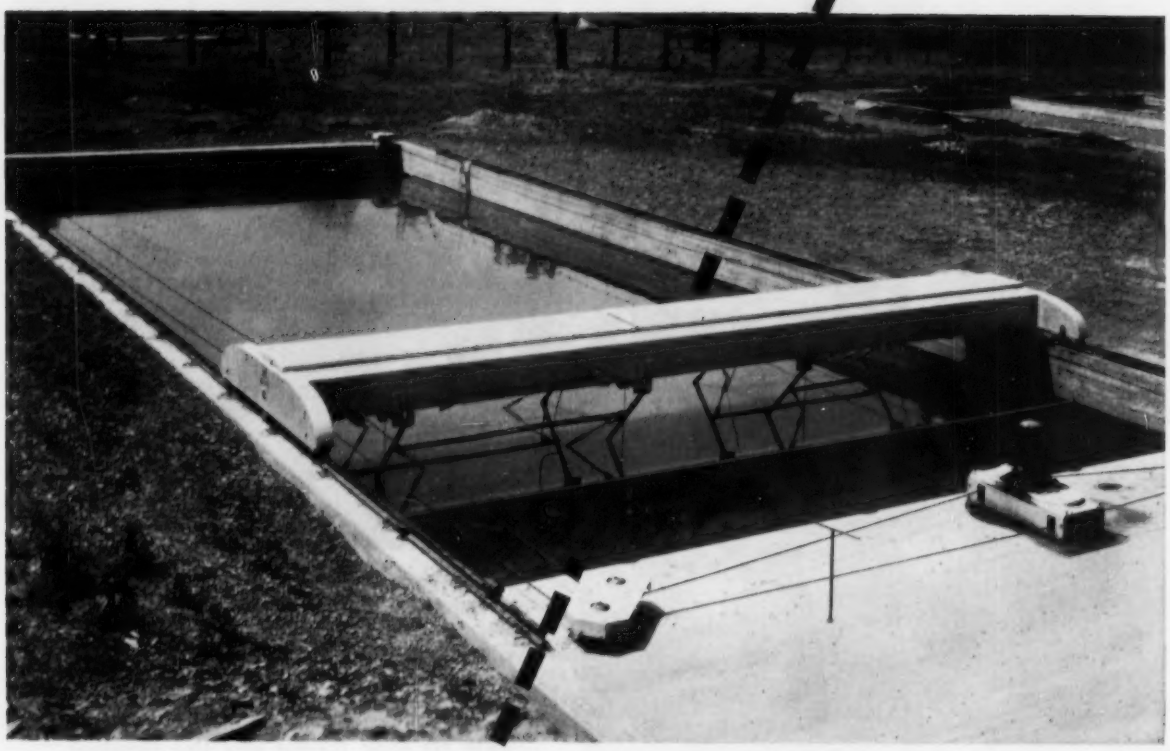
Here are some reasons why this plumbing contractor gets more production from his Sherman: Fast operating cycle; high visibility around other utility lines; and top-notch bell-hole performance. And the local Ford Tractor dealer, having sold so many, is equipped and skilled to keep his machine on the job, working at peak output without costly downtime.

See your local Ford Tractor dealer TODAY for a demonstration or write for Bulletin No. 3345.

Sherman
PRODUCTS, INC.
ROYAL OAK, MICHIGAN
POWER DIGGERS* • FRONT END LOADERS • FORK LIFTS

*Designed, Engineered and Manufactured jointly by Sherman Products, Inc., Royal Oak, Michigan. Wain-Roy Corporation, Hubbardston, Mass.

"POSITIVE OIL REMOVAL IN REFINERY WASTE TREATMENT"



...with the **Dorrco Monorake** *– the modern and economical method of cleaning oil-water separators*

Positive and Complete Oil Removal . . . Oil is positively and completely removed by skimmers after each cycle.

Long Life — Minimum Maintenance . . . a simple, rugged unit with accessibility of operating parts provides ease of adjustment and minimum maintenance.

Wide Range of Sizes . . . Monorake Units are available in widths ranging from 10 to 110 ft.

Versatile . . . The oil trough and sludge hopper can be installed at either the influent or the effluent end. Placement of oil trough at same end as sludge hopper provides for convenient testing and simplified operation.

For a more complete picture on the advantages and operation of the Dorrco Monorake, write for Bulletin No. 6001 — just off the press. No obligation, of course.

DORR-OLIVER
INCORPORATED
WORLD-WIDE RESEARCH • ENGINEERING • EQUIPMENT
STAMFORD • CONNECTICUT • U.S.A.

BRIEFS

for buyers of

Caustic Soda
Muriatic Acid

Some tips on supply logistics

Like all Hooker plants, this one in Montague, Michigan, is near deep water for a purpose—a purpose you might consider when choosing a supplier.

The water gives our customers the option of barge as well as rail delivery.

For many, the barge service means cheaper delivery. For others, it offers an alternative means of shipment in case of interruption in rail service.

Here are three other "pluses" to consider when you select a chlorine-caustic supplier. (As a Hooker customer, you enjoy all of them):

1. Competent engineering help. An experienced supplier can give you assistance in designing or revamping your chlorine or caustic soda handling system.

2. Operating assistance. Your supplier's technical servicemen can often spot—and help you correct—operating troubles before they become serious. Do you get the advantage of periodic technical service visits?

3. Safety programs. Your supplier should be able to give you up-to-date advice on safe equipment and handling methods.

We'll be glad to enlarge on these points, with your requirements in mind. Simply phone or write the nearest Hooker sales office.

New booklet, pocket size, offers useful facts on buying caustic soda.

Besides information on forms, grades, and shipping containers, contents include a factual discussion on 50% *vs.* 73% liquid caustic, and a handy nomograph to help you figure which strength is your better buy.

There's also a nomograph to help you estimate your requirements for various process solutions.

Check the coupon for a copy.

Off-color problem. That's what iron, sulfates, and other impurities in muriatic acid can be to your production men.

Let even small amounts of these materials sneak into your production, and products that should be white may come out yellow; equipment may gum up with insoluble precipitates; yields may be reduced considerably.

Enter Hooker White Grade muriatic acid with these sterling credentials: iron content, .0001% at most; sulfates, .003%; free chlorine, none; arsenic, none; organic matter, only .0002%. Probably the purest muriatic you can buy anywhere in volume.

For requirements only slightly less stiff, we recommend Hooker Commercial Grade muriatic: iron, .0005%; free chlorine, a trace; sulfates, .003%; organic matter, .001%; arsenic, none.

If muriatic acid is a problem in your processing, you can probably improve matters with one of these exceptionally pure grades. Either is available in 13-gallon carboys and in rubber-lined tank cars, in three strengths: 18°, 20°, 22° Baumé.

For further technical data, simply clip the coupon. Write us on your business letterhead for samples.

Check items you'd like to receive:

- ☐ *Caustic Soda Buyer's Guide*
- ☐ Technical data on caustic soda
- ☐ Technical data on muriatic acid

For information on these other Hooker chemicals used in the petroleum industry, check below:

- ☐ Antimony Trichloride, anhyd.
- ☐ Aluminum Chloride, anhyd.
- ☐ Sulfur Chlorides

Clip to your letterhead with your name and title and mail to us.

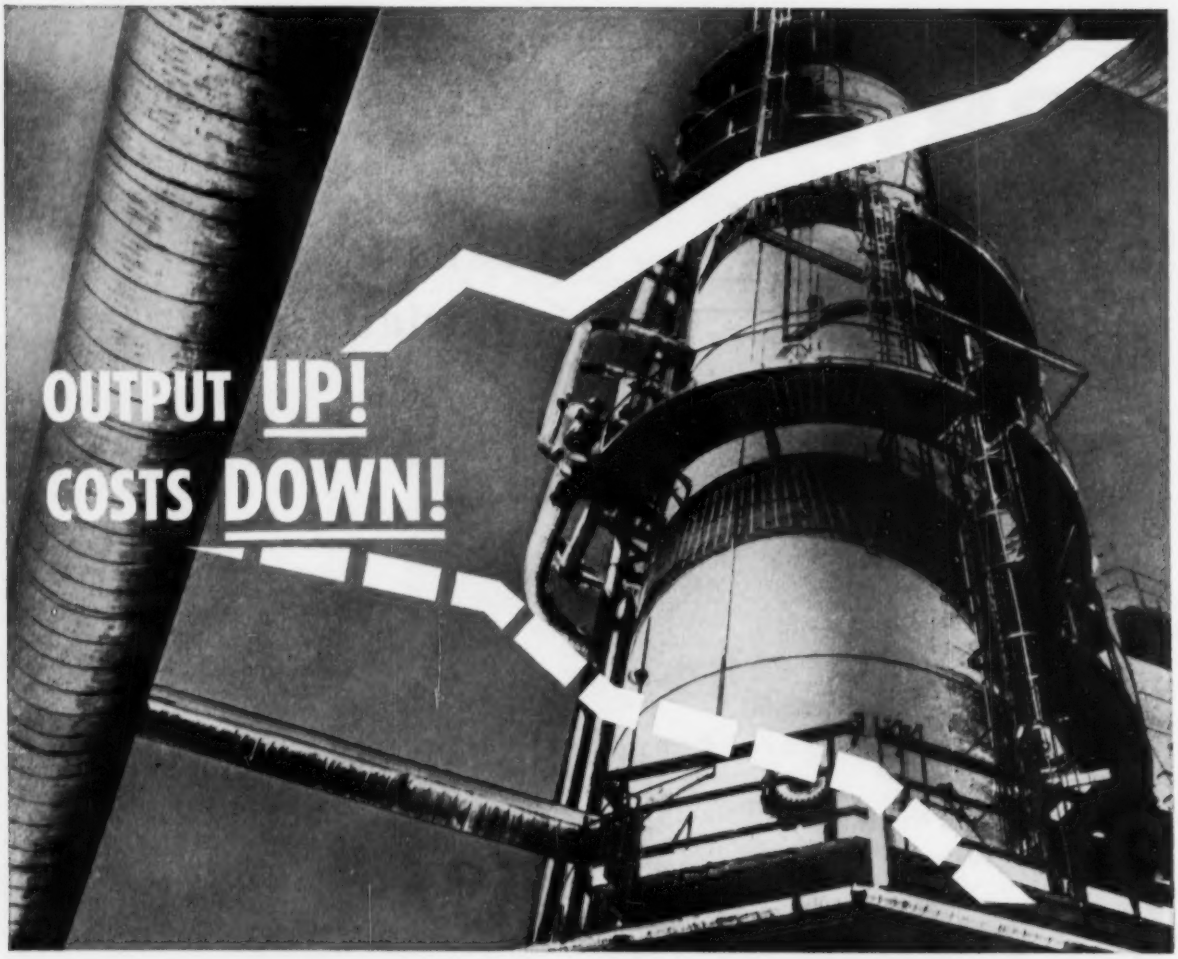
HOOKER CHEMICALS PLASTICS

HOOKER ELECTROCHEMICAL COMPANY

1609 FORTY-SEVENTH STREET, NIAGARA FALLS, N. Y.

NIAGARA FALLS • TACOMA • MONTAGUE, MICH. • NEW YORK • CHICAGO • LOS ANGELES

6-1745



with METEX Hi-Thruput MIST ELIMINATORS

METEX Hi-Thruput Mist Eliminators, installed in process towers and vessels, effect sharp separation of liquids and gases. Quality and yield are increased. Valuable liquids are knocked out and returned. Contamination of subsequent processing is removed. Turbines and compressors are protected from damaging liquids. Where build-up of coke or solids is a consideration, on-stream service life is increased three to four times. Air pollution is reduced, too.

METEX Hi-Thruput Mist Eliminators provide virtually 100% removal efficiency, even at extreme temperatures and pressures. Pressure drop is negligible. Their outstanding performance is due to repositioning of the wires by the METEX patented Herringbone Fold . . . an exclusive development of the originators of knitted wire mesh entrainment separators. Impingement target area is increased and stagnation points reduced.

In any processing equipment or vessels where liquid entrainment is a contributing factor in design or operation, specify METEX Hi-Thruput Mist Eliminators to assure greater production, improved quality of yield and substantially reduced operating and maintenance costs.

For complete information and specifications, write today for your free copy of Bulletin No. ME-6.

6-201

METAL TEXTILE CORPORATION ROSELLE, NEW JERSEY

Metal Textile Corp. of Canada, Ltd., Hamilton, Ontario • Representatives in principal cities throughout the world

Another client benefits from a BMC "Precious Plus"

Esso Unit Completed ... 21 days early!

To meet urgent production needs, a quick, quality job was desired on construction of a new process unit at an Esso Standard Oil Company refinery.

BMC Engineering accepted the challenge . . . and with a Key Man* in charge, put the unit on stream — at full capacity — *twenty-one precious days ahead of schedule!*

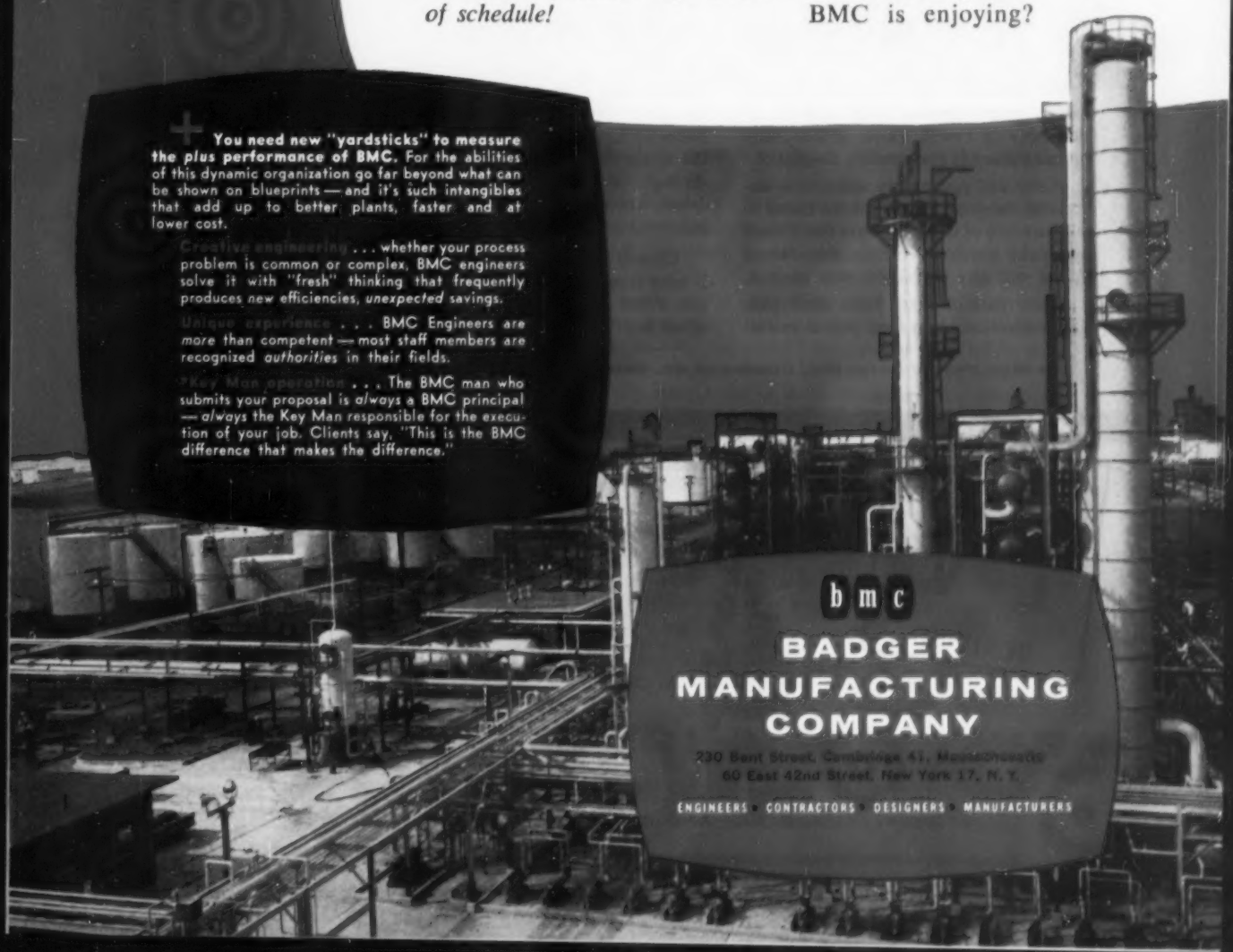
Speed was the need — with efficiency, of course. This was the "Precious Plus" in BMC's performance which never can be shown on blueprints — for it is the product of many intangibles. Other leading companies, too, find BMC's *plus* in performance of *precious* advantage. How else explain the unusual growth BMC is enjoying?

You need new "yardsticks" to measure the *plus* performance of BMC. For the abilities of this dynamic organization go far beyond what can be shown on blueprints — and it's such intangibles that add up to better plants, faster and at lower cost.

Creative engineering . . . whether your process problem is common or complex, BMC engineers solve it with "fresh" thinking that frequently produces *new* efficiencies, *unexpected* savings.

Unique experience . . . BMC Engineers are *more* than competent — most staff members are recognized *authorities* in their fields.

***Key Man operation** . . . The BMC man who submits your proposal is *always* a BMC principal — *always* the Key Man responsible for the execution of your job. Clients say, "This is the BMC difference that makes the difference."

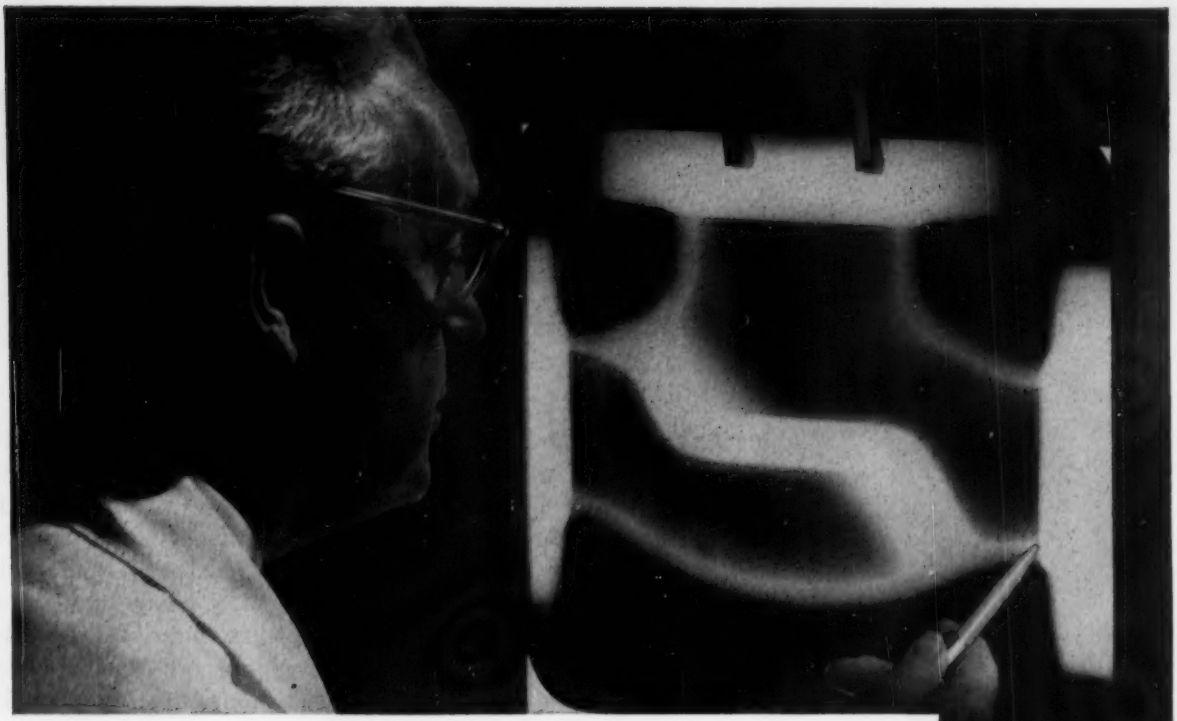


bmc

BADGER MANUFACTURING COMPANY

230 Bent Street, Cambridge 41, Massachusetts
60 East 42nd Street, New York 17, N. Y.

ENGINEERS • CONTRACTORS • DESIGNERS • MANUFACTURERS



Inside story:

Valves may look alike on the surface. Their performance is another story. And the inside story of Powell Valves is that *every* Powell Valve has *Performance Verified.*

X-ray and gamma ray inspection—examining the very structure of the metal itself—are two of the many ways that Powell can make absolutely certain that Powell Valves will give *dependable* flow control.

Every part of every valve must pass rigid inspection. As a final step in manufacture, every Powell Valve is subjected to *an actual line test.* Because of Powell's pains-taking quality control, valve repair is cut to the minimum and plant shut down through valve failure is substantially reduced. Records from refineries, power and industrial plants the world over prove it.

Consult your Powell Valve distributor. If none is near you, we'll be pleased to tell you about our COMPLETE *quality line* which has PERFORMANCE VERIFIED.

The Wm. Powell Company, Cincinnati 22, Ohio . . . 110th YEAR

PERFORMANCE PV VERIFIED

FIG. 1503—150-Pound Steel Gate Valve.

FIG. 6003—Steel Gate Valve for 600 Pounds W.S.P.

FIG. 6061—600-Pound Steel Swing Check Valve.

POWELL VALVES

BRONZE, IRON, STEEL AND CORROSION RESISTANT VALVES.

. . . there's enough difference to make ALL the difference

At final inspection, each individual Scovill Heat Exchanger Tube is checked for diameter, wall thickness, concentricity and length, to conform to permitted tolerances under pertinent specifications.

Inherent, however, in the quality of the alloys from which these tubes are drawn are many other distinctive "differences." Phosphorized Admiralty Heat Exchanger Tubes, for example, are initially hot extruded from billets made by Scovill's unique continuous casting process. In this process, continuous "blending" of the alloy from many melts produces exceptionally uniform metal . . . with even distribution of optimum inhibitor (phosphorus) content. The net result:—more perfect finished tubes . . . smooth, dense, free from surface defects . . . uniform in chemical composition . . . fully protected for long service life . . . delivered to the user in perfect condition.

On your next installation, let us show you how these "differences" in Scovill Heat Exchanger Tube can lead to superior field performance. A comprehensive range of standard tube alloys is available to meet every condition. Scovill's Technical Service is always ready to help you with special problems.

Scovill Manufacturing Company, Mill Products Division,
99 Mill Street, Waterbury 20, Connecticut. Phone Plaza 4-1171.

SCOVILL **HEAT EXCHANGER TUBE**

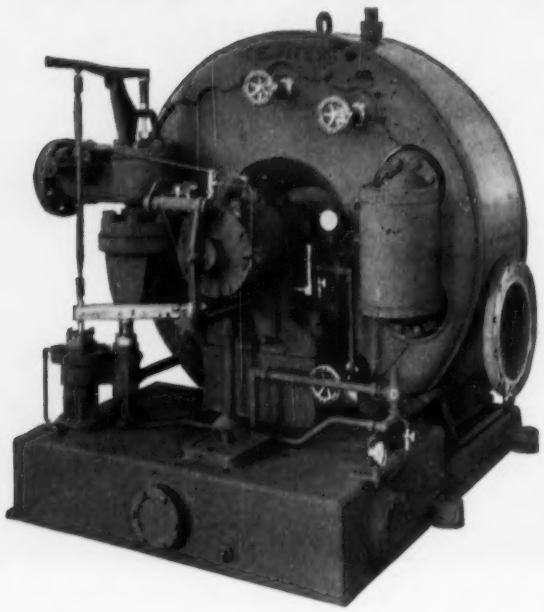
FOR APPLICATIONS FROM MARINE TO PETROCHEMICAL . . . FROM COMPRESSOR INTERCOOLERS TO "CAT-CRACKER" EXCHANGERS.

Phosphorized Admiralty • Admiralty • Arsenical Admiralty • Muntz Metal • Naval Brass • Red Brass, 85% • Deoxidized Copper
Arsenical Copper • Copper Nickel, 10% & 20% • Cupro Nickel, 30% • Aluminum Brass • Aluminum Bronze, 5% • Duplex Tube

17SC56

For more data on advertised products, use Readers' Service Cards, last page.

TROUBLE-FREE TURBINE OPERATION STARTS HERE



Terry solid wheel turbines have become a symbol for dependable, trouble-free operation. The reason—simplicity and ruggedness of construction.

Take the rotor, for instance. It's a solid forging in which a series of semi-circular buckets is milled. There are no separate parts to loosen or work out. Since the only function of the blades is to form a series of pockets, any wear which might occur would not materially affect horsepower or efficiency.

It is impossible for the blades to foul. They have large clearances and are further protected by the projecting rims at the sides of the wheel. As the side clearances are also very large, end play can do no harm.

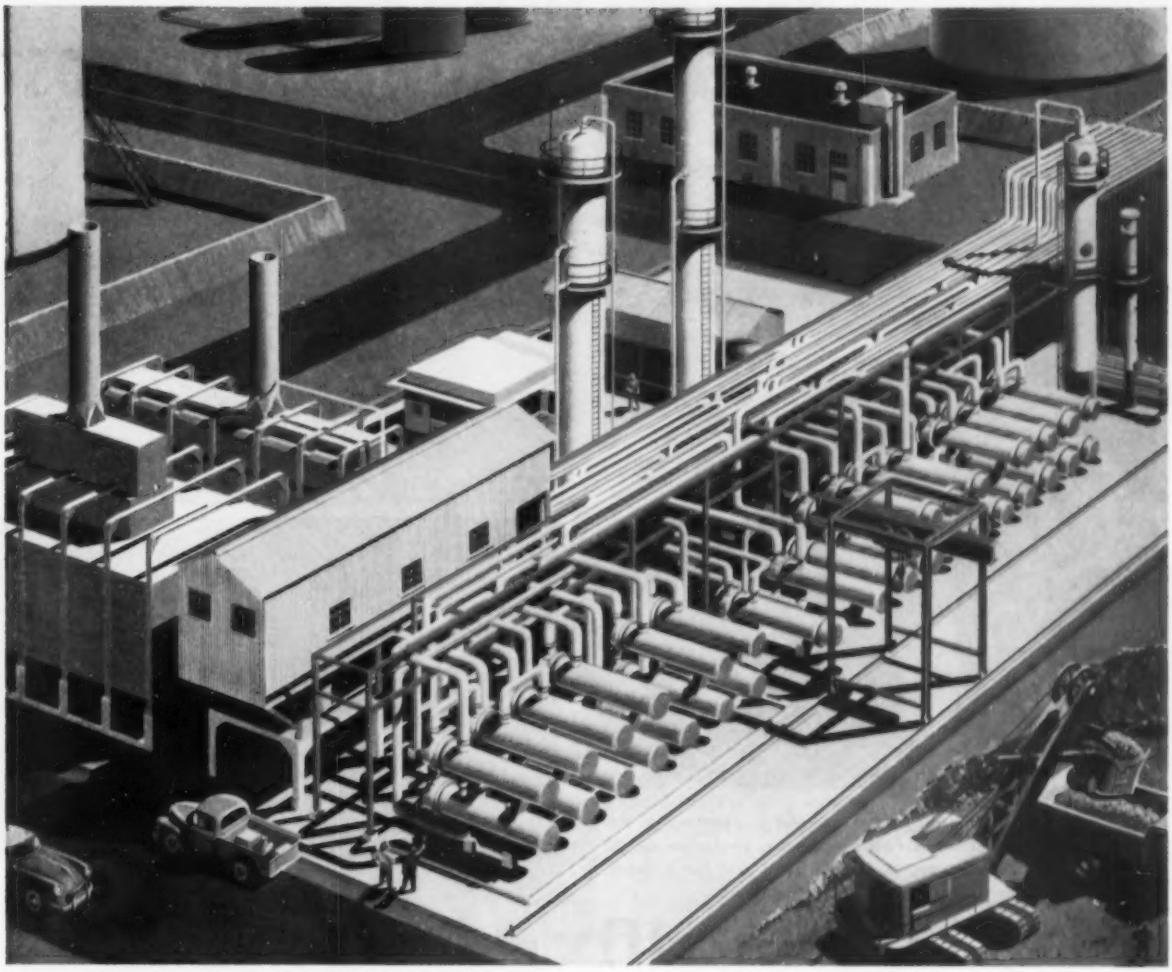
Simplicity outside too—as you can see from the photograph of the 1500 HP at 3500 RPM solid wheel turbine above. This turbine is equipped with an oil relay governor and forced feed lubrication to the bearings.

For more about these *work horses of industry*, send for a copy of bulletin S-116. No cost or obligation.

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TERRY

TT-1200



not one... but two 15,000 b/d CATFORMERS for ATLANTIC

Blaw-Knox is designing and constructing two Catformers and Unifiners for THE ATLANTIC REFINING COMPANY. One to be installed in their Philadelphia refinery, the other for Atreco, Texas.

The units are identical, each having a reforming capacity of 15,000 barrels per day.

To save both construction time and costs, this project was planned to take advantage of the engineering work for the first unit by adapting it directly to the second installation.

The background and experience of Blaw-Knox engineers in catalytic reforming and hydrogen treating, as well as other petroleum processes, are available to you in your expansion or new refinery plans. We welcome the opportunity to make recommendations.

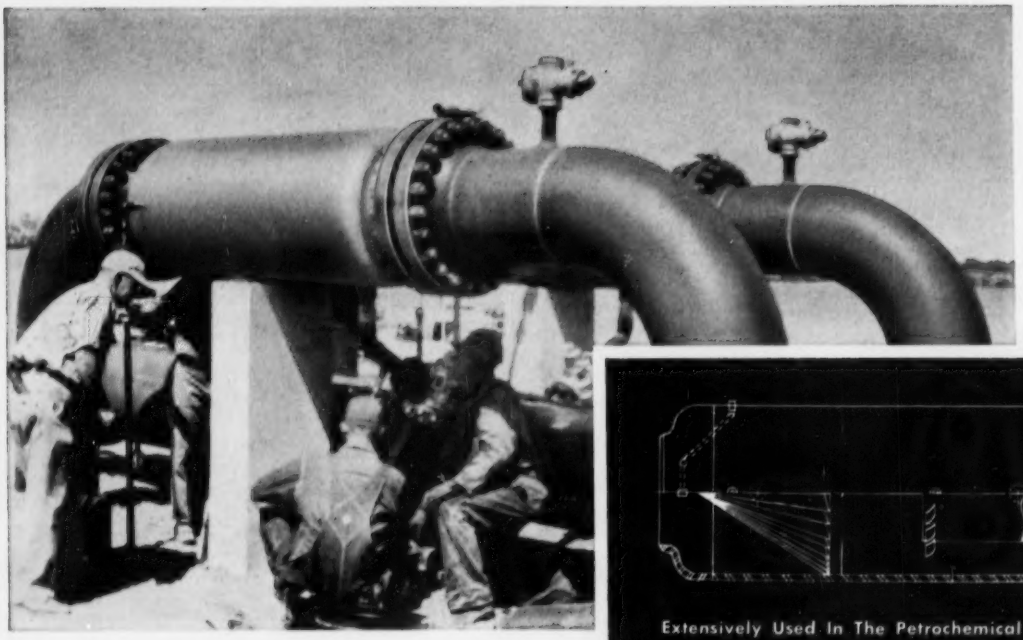
50th Anniversary
BLAW-KNOX
1906-1956

BLAW-KNOX COMPANY Chemical Plants Division
Pittsburgh 30, Pennsylvania • Chicago 1, Illinois
Birmingham, New York, Philadelphia, San Francisco, Washington, D. C.

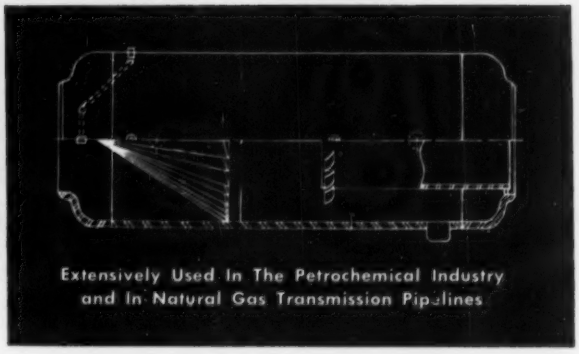
For more data on advertised products, use Readers' Service Cards, last page.

Why settle for less than

MAXIMUM EFFICIENCY AT LOWEST FIRST COST



Photograph of actual installation of a Centrifix 16 inch 1000 PSIG SRW Line Purifier with spray connection and 20 inch inlet and outlet. The overall length is 6 feet 6 inches.



Extensively Used In The Petrochemical Industry and In Natural Gas Transmission Pipelines

specify Centrifix RW Line Purifiers

You eliminate once and for all entrainment grief when you install Centrifix Line Purifiers. The high separating efficiency common to all Centrifix equipment is accomplished by application of properly controlled centrifugal and centripetal high-velocity forces initiated by the basic design. Entrainment is cast from the passing stream and is caused to drain through races and eject tubes.

In the natural gas unit illustrated, the purifier is equipped with a spray head just upstream of the helicoid tuyere forming the separator element. The purpose of this spray is to add just sufficient oil to the tuyere blades to wet their surfaces and thus pick up entrained solids.

Only Centrifix gives you all of these exclusive features . . . Highest Separating Efficiency, Broad Range, Negligible Pressure Drop, Self Cleaning, Large Slug Capacity, No Moving Parts and Simple Installation. Let Centrifix engineers recommend the correct Centrifix solution to your line purifier problems.

Write today for Centrifix Engineering Manual and Catalog

THE

Centrifix

CORPORATION

3606 PAYNE AVENUE

CLEVELAND 14, OHIO

HASTELLOY Alloys in Convenient Forms

Trade-Mark

...for Superior Corrosion Resistance

EXTRA CORROSION RESISTANCE

Equipment made of HASTELLOY alloys is giving good service handling such severe corrosives as boiling hydrochloric and sulphuric acids. The alloys are also used to handle these acids at lower temperatures and in all concentrations. HASTELLOY alloys are the most economical material for handling such reactive materials as hydrogen fluoride and wet hydrogen chloride gas at high temperatures. The alloys are also highly resistant to wet chlorine, acid salts, phosphoric acid, nitric acid, and organic acids.

AVAILABLE IN STANDARD FORMS

HASTELLOY alloys are available in all of the standard mill forms—sheet, plate, bars, rods, wire, tubing, pipe, fittings, and fasteners. They can be obtained as sand and investment castings.

TEST THEM NOW

Samples for trying HASTELLOY alloys under actual plant conditions are available without charge. Get in touch with the nearest Haynes Stellite Company office and describe the corrosive conditions involved.

HAYNES STELLITE COMPANY

A Division of Union Carbide and Carbon Corporation

UCC

General Offices and Works: Kokomo, Indiana

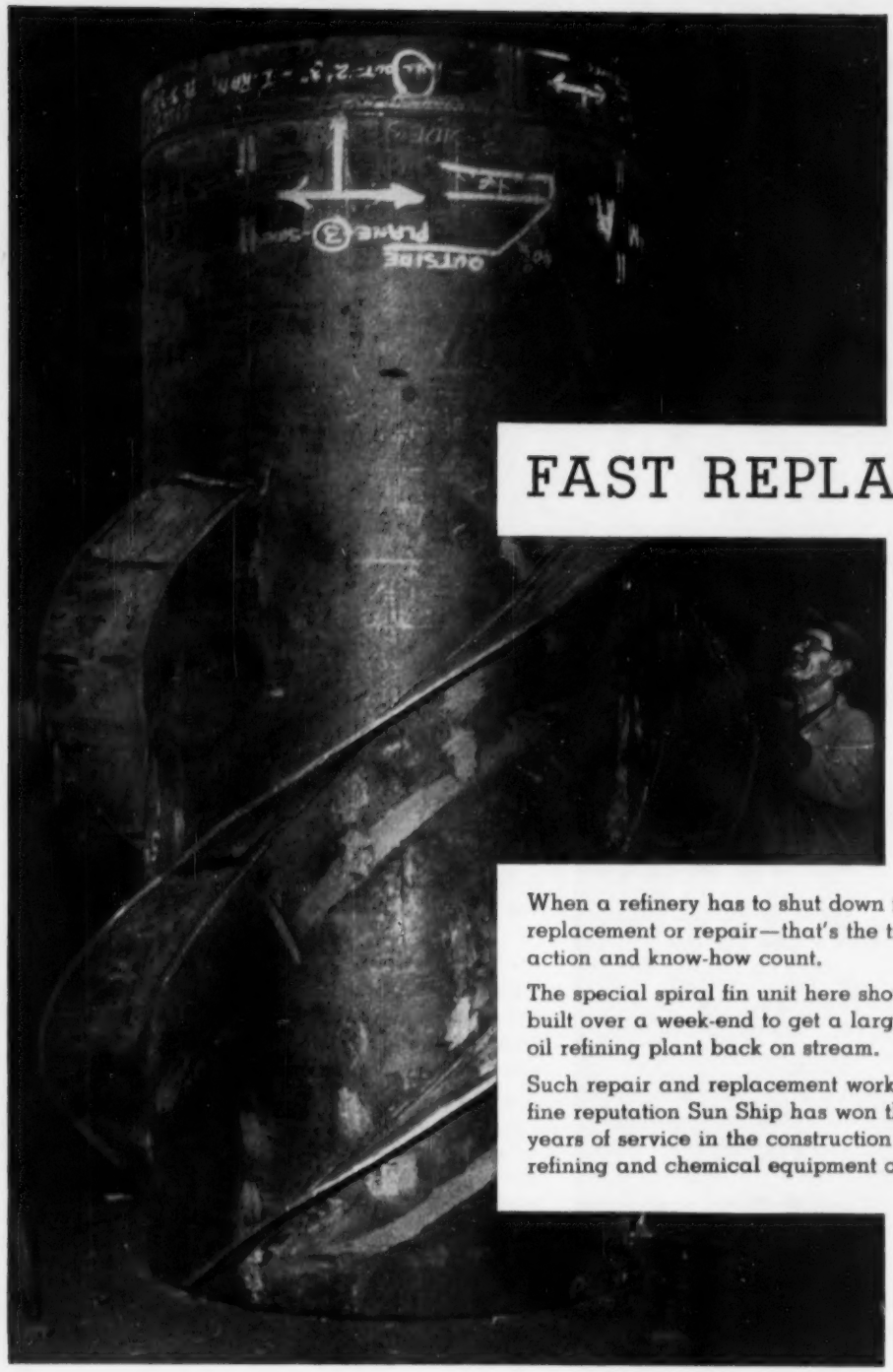
Sales Offices

Chicago · Cleveland · Detroit · Houston

Los Angeles · New York · San Francisco · Tulsa

"Haynes" and "Hastelloy" are registered trade-marks of Union Carbide and Carbon Corporation.

For more data on advertised products, use Readers' Service Cards, last page.



FAST REPLACEMENT

When a refinery has to shut down for a replacement or repair—that's the time when action and know-how count.

The special spiral fin unit here shown had to be built over a week-end to get a large oil refining plant back on stream.

Such repair and replacement work has added to the fine reputation Sun Ship has won through years of service in the construction of oil refining and chemical equipment of every kind.

Sun

SHIPBUILDING & DRY DOCK COMPANY

ON THE DELAWARE SINCE 1916 CHESTER, PA.

Richard C. Waldron, Okonite's Manager of Engineering, explains:

How to tell right from wrong in plastic control cables

With hundreds of compounds to choose from, it's easy to make an incorrect choice when selecting thermoplastic control cable for refinery, natural gas and petrochemical use. The wrong choice can be extremely costly.

Specific Okonite plastic cable insulation and sheath compounds make your selection easier

Okonite has recently introduced several Okoseal (polyvinyl chloride) and Okolene (polyethylene) insulations and sheaths compounded to Okonite's own formulas. From these you can select the exact combination of insulation and sheath for your specific environment: salt water, petroleum oils, paraffinic hydrocarbons, alcohols, mineral acids, fixed alkalies, ketones, esters, halogenated hydrocarbons.

Make your selection from these new bulletins

Especially compiled for the petroleum and petrochemical industries, the following bulletins give complete technical information, including dimensions, on Okonite plastic cables for power, control, machine tools, lighting circuits, motor leads, switchboards, communications and cathodic protection.

THE OKONITE COMPANY, Passaic, N. J.
Kindly send me the free bulletins checked below.

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- ☐ **BULLETIN 2121**—Machine Tool and Switchboard Wire—600 Volts (Okoseal 200)
- ☐ **BULLETIN 2122**—High Ambient Petroleum and Chemical Resistant Wire—600 Volts (Okoseal 300)
- ☐ **BULLETIN 2123**—Oil and Gas Resistant Wire—600 Volts (Okoseal-Nylon, Type OGR)
- ☐ **BULLETIN 2124**—Multi-Conductor Control Cable—600 Volts (Okoseal 100)
- ☐ **BULLETIN 2125**—Insulated Power and Control Cable—0-5000 Volts (Okolene 400)
- ☐ **BULLETIN 2126**—Multi-Conductor Control Cable—600 and 1000 Volts (Okolene 400)
- ☐ **BULLETIN 2127**—Cathodic Protection Cable (Okolene 400)
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Unibestos...the only single-layer pipe insulation that provides positive protection at the joints

Unibestos is the only single-layer pipe insulation that's built with the strong, long interlacing fibers of Amosite, the quality asbestos from South Africa. This unique construction permits single-layer Unibestos to form positive heat seals at hard-to-insulate joints and fittings...to provide more protection against heat loss than other single- or even double-layer insulations.

With Unibestos on the job, there is less shrinkage...more resistance to moisture, acid and chemical fumes...greater toughness to withstand shock and vibration. Easy to miter, easy to cut, this durable insulation goes on the most complex pipeline systems quickly and economically.

Fast, low-cost application...long-lasting, positive protection—these are the reasons why Unibestos is becoming the specified insulation for more and more of today's industrial operations. Unibestos® is available in sectional form through 44" O.D.

Joe Bestos says:

Remember when insulating those tough fittings, single-layer Unibestos locks in more heat than other single- or double-layer insulations!

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all for one customer...

all for atomic power...

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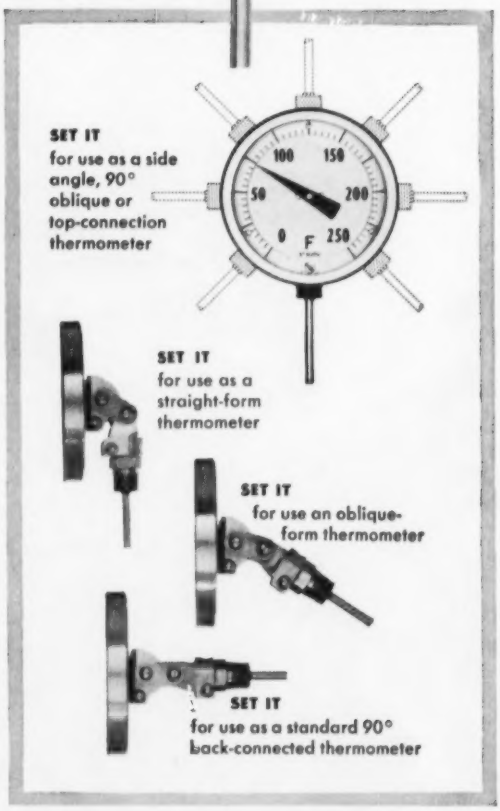
Install the new American "Every Angle" Bi-Metal Dial Thermometer anywhere – inside or out. Its climate-proof case defies any weather condition. The full use of these thermometers in any process plant makes possible temperature readings with the same ease and facility of those of a pressure gauge. Write today for complete information. Ask for Bulletin 148.

*Pat. App. For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for use as a side angle, 90° oblique or top-connection thermometer
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for use as a standard 90° back-connected thermometer

SPECIFICATIONS

5-Inch Type 5-6060 American "Every Angle" Bi-Metal Dial Thermometer

Temperature Ranges: From minus 80° to plus 1000° F. Accuracy within 1% of range. *Dial Size:* 5". Scale approximately 10½" long. *Bi-Metal Coil:* Low mass, with single helix close to inside wall of stem assures high sensitivity. Silicone fluid dampens vibration, accelerates transfer, speeds response. *Case:* Stainless steel. *Bezel:* Threaded to case. *Front:* Clear, extra-heavy glass set in channeled gasket to seal case. *Pointer:* Functional type, adjustable from front. *Stem:* Lengths – 4" to 24", 18-8 stainless steel. All joints welded. *Connection:* Fixed, ½" NPT. *Separable Sockets:* Available in all materials and sizes normally required.

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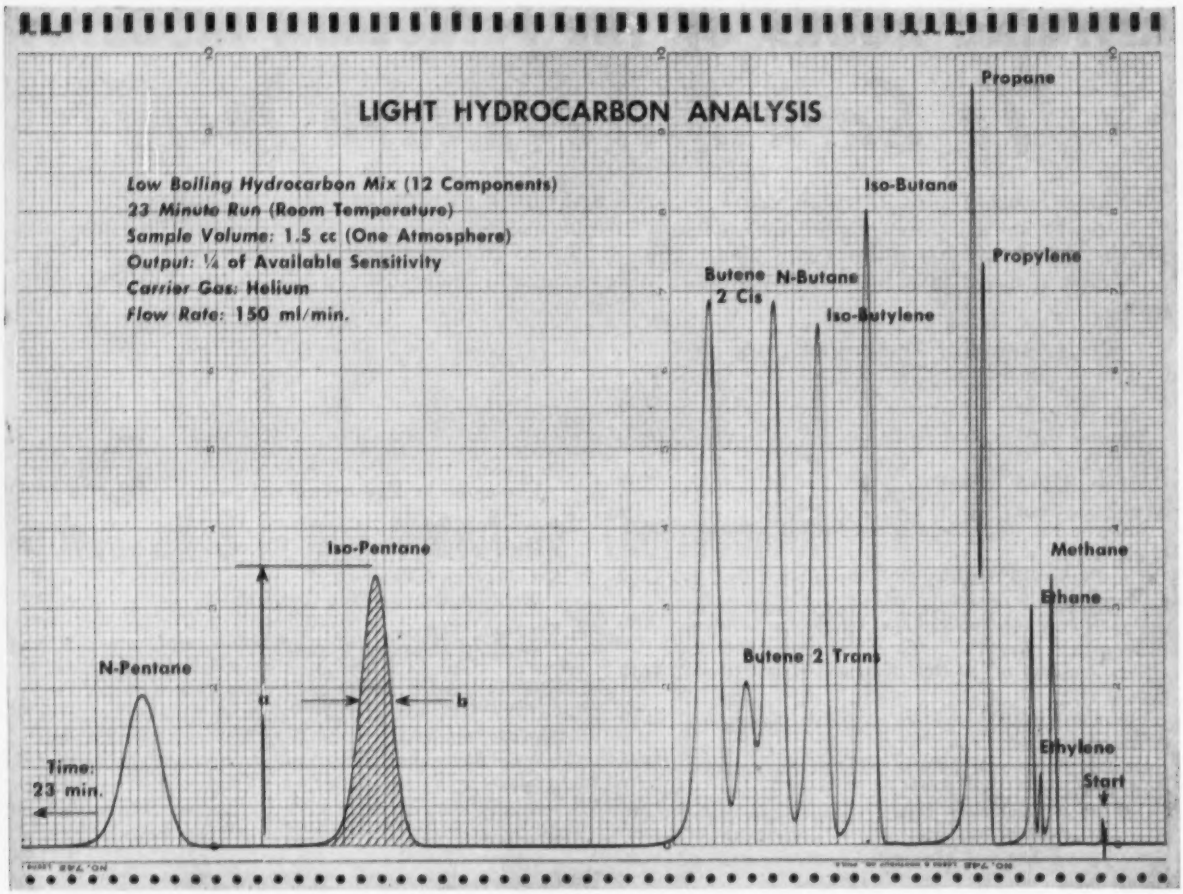

Photo of actual run made on new P-E Vapor Fractometer. To find mole % concentration of a component, analyst simply integrates area under peak by multiplying peak height (a) times half-band width (b).

This quantitative analysis took only 23 minutes
on the new P-E Vapor Fractometer that costs only $1,375

HOW LONG WOULD IT TAKE YOU?

Employing the principles of gas chromotography, P-E's new vapor fractometer is a revolutionary advance in the field of gas and volatile-liquid quantitative analysis. It is fast, precise, uncomplicated to operate, extremely simple in calculation, and above all, many times less expensive than distillation columns, mass spectrometer, or any other instrument for the purpose.

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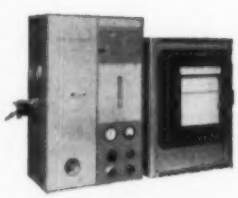
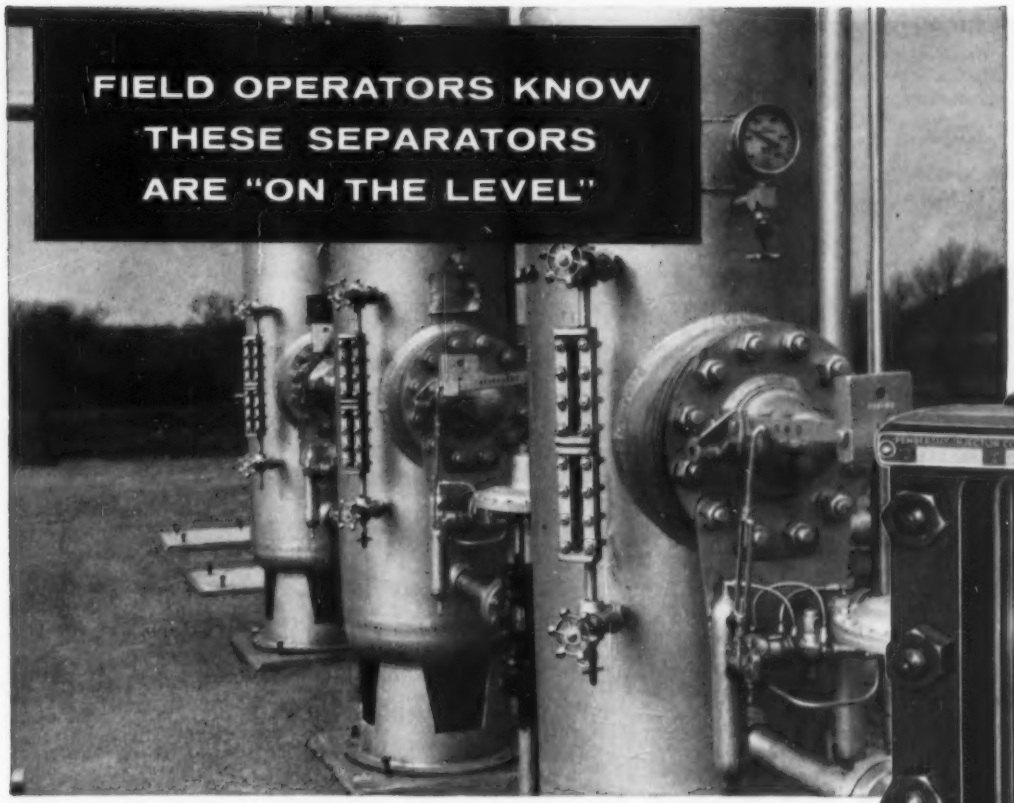
Take, for example, the analysis of a synthetic LPG mix shown above. Here 12 components, representing the hydrocarbons most frequently encountered, were clearly separated—a job extremely difficult to accomplish by ordinary vacuum distillation methods. The perfect shape of the recorder bands makes quantitative analysis simple and accurate. Area under each peak is the measure of the mole % concentration of the component. These area relationships are all that is needed for calculation, without preliminary calibration for each individual component.

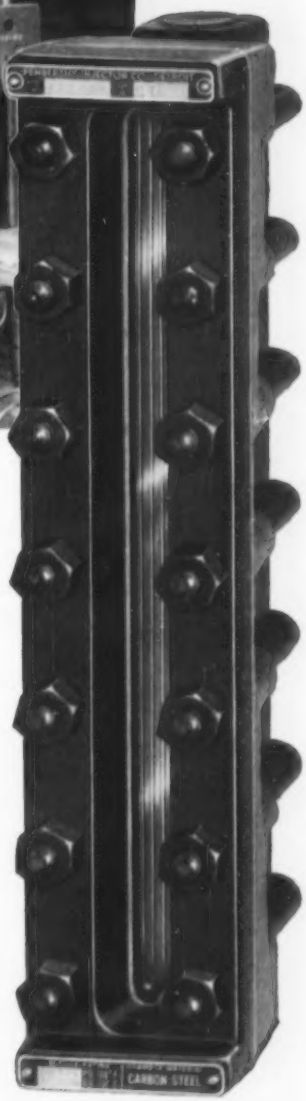
There is no faster, no simpler, no more inexpensive method in existence today.



This is the Model 154 Vapor Fractometer (recorder optional). Send for descriptive bulletin.

Perkin-Elmer CORPORATION
Norwalk, Connecticut





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These separators made by Black, Sivalls & Bryson, Inc., are used to extract liquids from air and gas lines. Removal of these liquids prevents damage to compressors and other mechanical equipment. In cold weather, they are helpful in preventing freeze-ups of gas transmission lines.

By standardizing on Penberthy direct-reading liquid level gages for use on vessels where liquid or interface levels must be observed, BS&B assures accurate readings under a variety of temperature and pressure conditions.

Because quality manufacturers, such as BS&B, realize that *less than the best is not good enough* . . . you are seeing more and more Penberthy gages at work on equipment in the Petro-Chemical industry.

Our new catalog #36 will show you why Penberthy products deliver unmatched performance. Write for your copy.

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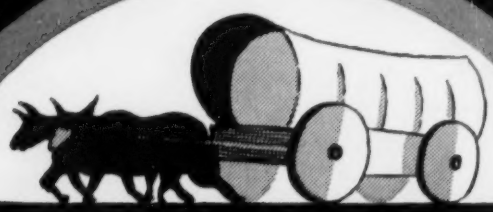

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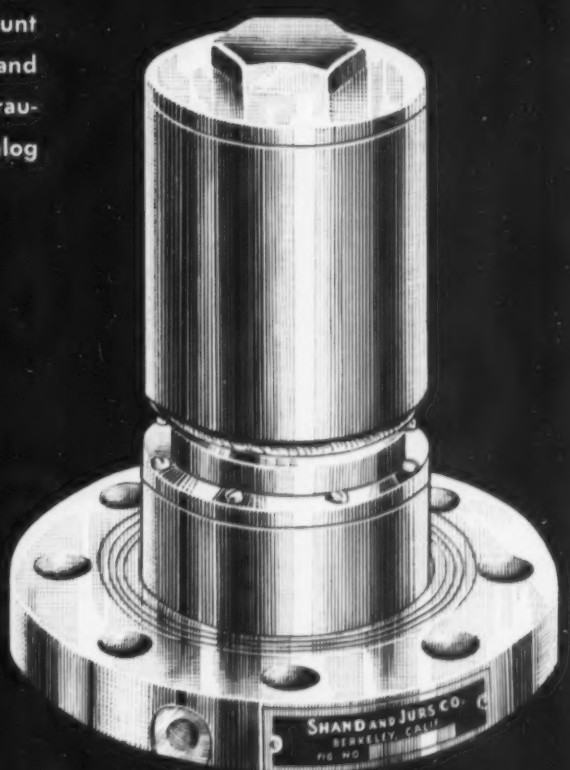
SHOWN here is the new S. & J. Hydraulically operated BALANCED Internal Safety Valve, which will remain in a closed position against various combinations of tank, line or manifold pressures. Since there is equal pressure on both sides of the cylinder bottom plate, this valve has been so designed that the area over which this pressure acts in the downward direction is greater than the area over which the pressure acts in the upward position. The result is that the force in the downward direction tends to seal the valve tighter with increasing line pressure. These valves are made in 3", 6" and 8" sizes. The 3" size operates with a single piston, while the 6" and 8" sizes employ a double piston to minimize the amount of hydraulic fluid required. Complete data and drawings on these valves and actuating hydraulic operators is contained in our new catalog HVS-HP, available upon request.



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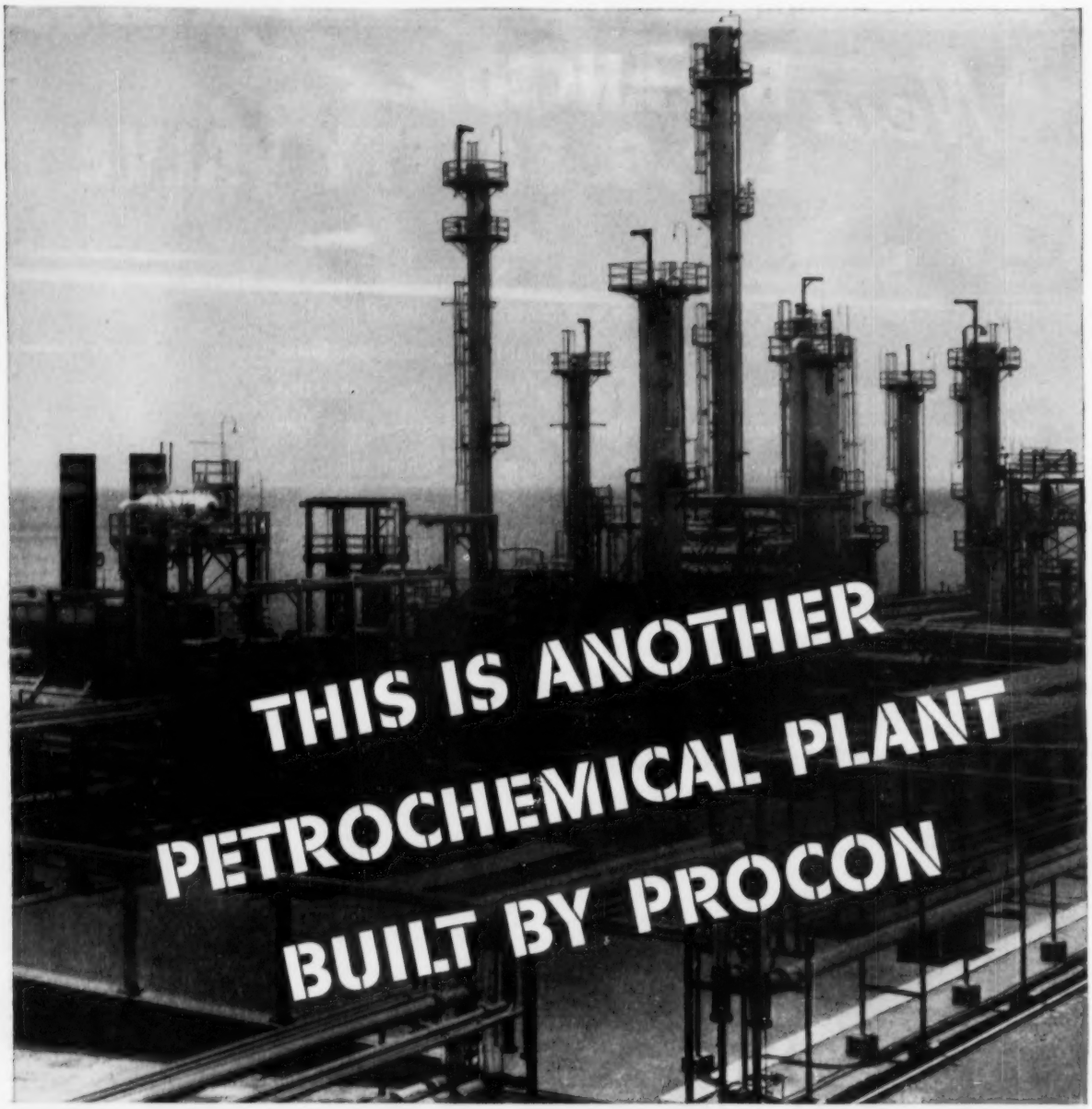

This fine plant overseas is just one example of Procon's continually growing accomplishments in petrochemical construction. Like all our projects, it was completed on schedule and up to every specification.

Procon's world-wide construction organization provides a complete service, including new plant construction, additional process facilities, expansion or modernization, to the petrochemical, chemical and oil refining industries. Our services are available to you, any time, anywhere.

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WHERE CLEANLINESS

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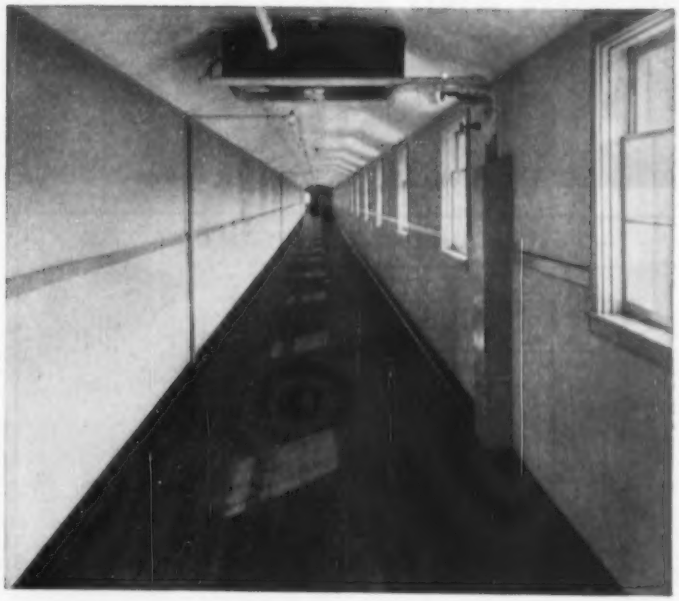


Hospital corridors must be easy to clean and safe from fire. The answer here is wainscoting of K&M Apac.

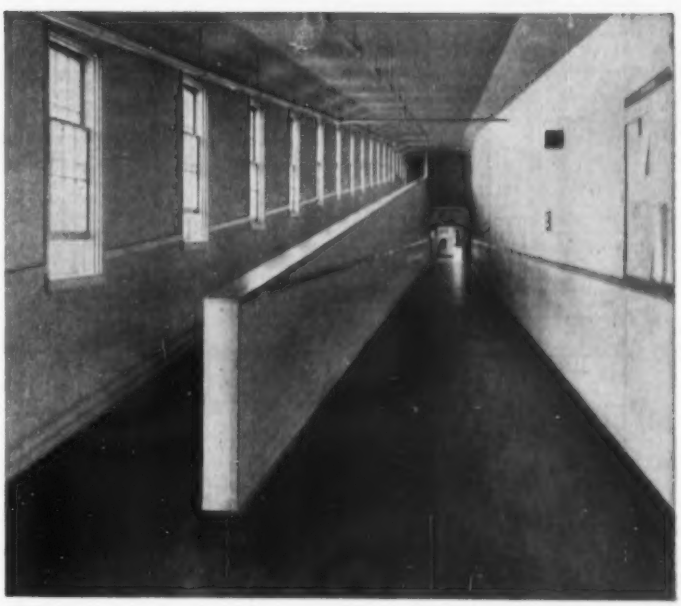
K&M "APAC" ASBESTOS SHEETS

These two illustrations show but one of many excellent uses for this material . . . use K&M Apac almost anywhere . . . as interior and exterior siding, office paneling, plant and office ceilings, machine shop sheathing, stock room sidewalls, basement partitions, linings for elevator casings; as inside-plant enclosures, as waste and storage bins, and even as hoppers.

K&M Apac is the ideal low-cost, long-life building material. It is made of two practically indestructible ingredients . . . asbestos fiber and portland cement . . . and actually grows harder and more durable with age. K&M Apac cannot burn, rot or corrode, nor can it be damaged by vermin or rodents. Apac is easily sanitized with soap and water.

PRACTICALLY NO MAINTENANCE NEEDED, indoors or out! K&M Apac sheets are highly weather-resistant. Their natural gray color is attractive and no painting is required for protection.

INEXPENSIVE APPLICATION is possible with K&M Apac . . . large 4′ x 8′ sheets can be applied on a big area quickly, and even unskilled labor can cut, drill or shape them on the job without special equipment.



K&M Apac is ideal for this ramp-wall which must be rugged to withstand the continuous scuffing and scraping of heavy traffic.

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K&M best in asbestos®

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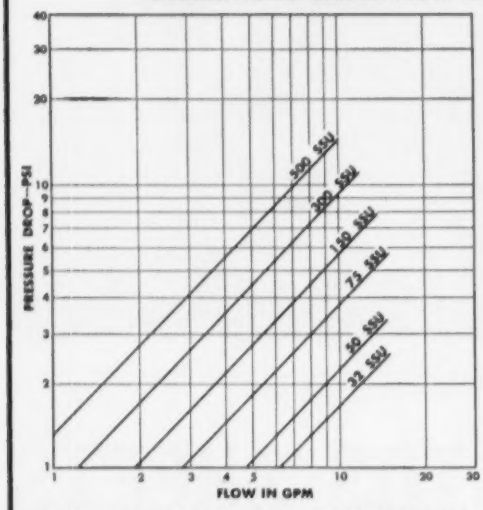
DESIGN AND APPLICATION NOTES ON

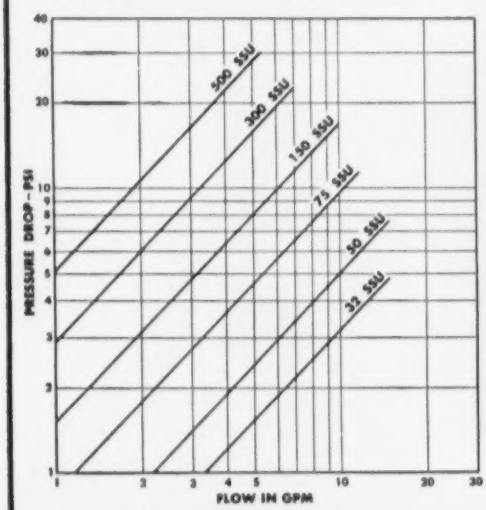
Cuno's new Poro-Klean Filter

TYPICAL PORO-KLEAN FLOW DATA



CYLINDRICAL TYPE

FLOW DATA FOR TYPICAL CYLINDRICAL-TYPE, coarse-grade, PORO-KLEAN filter element, fluid viscosity as parameter. Filtration to 15 microns.



CELL TYPE

FLOW DATA FOR TYPICAL CELL-TYPE, medium-grade, PORO-KLEAN filter element, fluid viscosity as parameter. Filtration to 5 microns.

Precision 3-to-30 micron filter for high temperature and high pressure

PORO-KLEAN, Cuno's new porous stainless steel filter material, now offers the chemical, petrochemical, nuclear, and process industries true micronic filtration for temperatures to 900°F and differential pressures to 2000 psi.

Standard in 316 stainless steel, with low carbon content (0.03 to 0.05% max.), PORO-KLEAN is an ideal filter material for use in applications requiring corrosion resistance, high strength (ultimate tensile strength: 25,000 psi), high resistance to hydraulic shock, or positive freedom from fluid contamination.

Typical PORO-KLEAN applications, already in use in the chemical and process industries, are listed below. Approximate flow-rate curves for typical cell and cylindrical standard elements are shown at left (for exact data, see your Cuno representative).

TYPICAL PORO-KLEAN APPLICATIONS

TO REMOVE:

- Resin and airborne contamination from demineralized water
- Fixed-bed catalyst fines from petroleum products
- Over-cooked gels from polymers
- Radioactive contamination from light and heavy water
- Fine precoat particles downstream from primary filters
- Contamination and/or catalysts from high-temperature and high-pressure refinery gases
- Metal oxides from molten sodium, sodium-potassium, and bismuth
- Iron oxides from fuels
- Rust from steam
- Foreign matter from pharmaceuticals

TO RECOVER:

- Catalysts from gases and liquids

TO DISPERSE:

- Gases into liquids and other gases

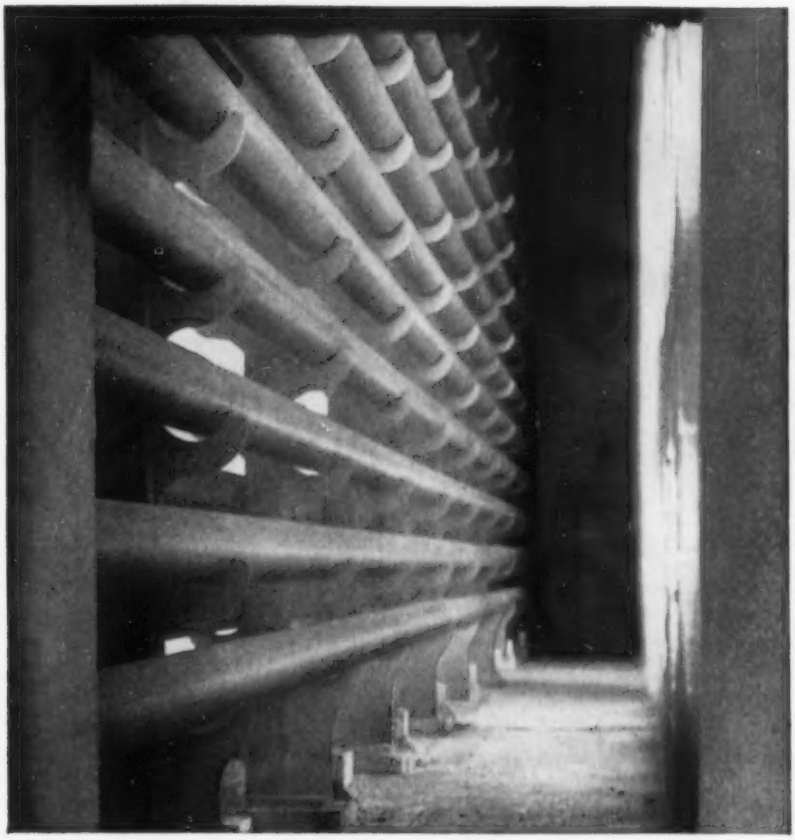
If you have problems like these, let Cuno engineers help you apply PORO-KLEAN to their solution. See your Cuno representative, or write Cuno Engineering Corporation, 33-7 South Vine Street, Meriden, Conn. 5.20

CUNO

ENGINEERED FILTRATION

Removes More Sizes of Solids From More Kinds of Fluids

AUTO-KLEAN (edge type) • MICRO-KLEAN (fibre cartridge) • FLO-KLEAN (wire-wound) • PORO-KLEAN (porous stainless steel)



Incoloy tubes on firing line — In the reaction zone of the Selas furnace, lowest and hottest area, 18 Incoloy tubes carry the stream. Maintenance is very slight.

Battery of 8 Selas cracking furnaces producing ethylene at Gulf Oil's new No. 2 unit from ethane or propane. Independent regulation of banks of burners controls temperature and compensates for wide variations in feed stock composition. Absence of open flame permits compact construction and promotes uniform heating . . . adding to tube life and reducing coking.

Incoloy furnace tubes safeguard ethylene supply

. . . aid production continuity in million pound/day Gulf plant

Ethylene is as basic as bread to the petrochemical industry. Continuous, reliable supply is essential.

That's why Gulf Oil Corporation's completion of the No. 2 Unit in its Port Arthur plant is sparking petrochemical development in Texas' Gulf Coast.

New facility assures ethylene at million pound/day level

At the feed end, Gulf's own big nearby refinery is a stable source of ethane and propane. At the distribution end, extensive, highly flexible ethylene storage and pipeline facilities keep product availability at a steady high level.

So does the plant itself. It is designed for maximum continuity of production.

Take the tubes in the cracking furnaces, for example. In the high temperature reaction zone, they are Incoloy* iron-nickel-chromium alloy.

Under prolonged exposure to such conditions, Incoloy alloy is stably austenitic and shows excellent resistance to carburization — providing a factor of safety during decoking if temporary hot spots were to develop.

Speaking of No. 1 Unit, Gulf states: "*These tubes have been in actual cracking service over 9000 hours. Maintenance has been very slight . . . mainly replacing one or two feet at the outlet end of several tubes.*" (An easy repair with weldable Incoloy.)

As a result of this experience, Gulf is using 72,000 pounds of Incoloy alloy tubing in the reaction zones of the battery of the 8 new Selas furnaces.

As an extra bonus . . .

Gulf realizes a distinct price advantage in using Incoloy tubing in the relatively inexpensive extruded form.

If the selection of furnace tube materials is your responsibility, you will want to know the advantages of Incoloy. It's easy to get the facts. Just write Inco's Development and Research Div.

*Registered trademark of The International Nickel Company, Inc.

The INTERNATIONAL NICKEL COMPANY, Inc.
67 Wall Street New York 5, N. Y.

INCO

Incoloy . . . *for heat-resisting use*

For more data on advertised products, use Readers' Service Cards, last page.

US RUBBER PACKINGS

SIMPLIFY YOUR PACKING PROBLEMS

these 6 packings will handle most of your requirements

STYLE 193

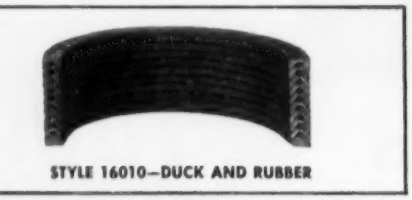
STYLE 193—U. S. CENTRIFUGAL PUMP PACKING

For centrifugal pumps, or other rotating or oscillating rods or shafts, handling hot or cold, fresh or salt water, oil, brine, weak acids, caustic solutions and ammonia. Made of long fibre asbestos yarn, plaited square. Each strand thoroughly lubricated and graphited.

STYLE 101—U. S. RAINBESTOS HIGH-PRESSURE ROD AND PLUNGER PACKING

Designed for high-pressure steam, air and gas up to 500° F. Made from selected asbestos cloth, woven from tightly twisted asbestos yarn, with a genuine U. S. Rainbow non-hardening cushion, formed square, and treated with heat-resisting lubricants and preservatives and with a graphite solution.

STYLE 101



STYLE 16010—DUCK AND RUBBER

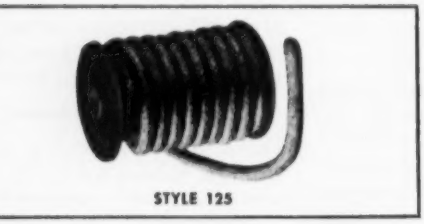
STYLE 16010—U. S. MATCHLESS PACKING

Matchless is the high-pressure packing—will withstand hydraulic pressures as high as 8000 pounds. Self-adjusting, automatic action results in reduced wear and tear on rods and plungers, minimizes friction, keeps down packing costs. For hydraulic equipment, presses, rams, triplex pumps, outside packed pumps, and swivels on rotary drilling rigs.

STYLE 463—U. S. PEERLESS CANVAS PUMP PACKING

For service on inside packed pumps against hot or cold water, and for end rings in hydraulic sets. Made from first quality, closely woven duck laminations cemented together with a high quality rubber friction. Light in weight.

STYLE 463



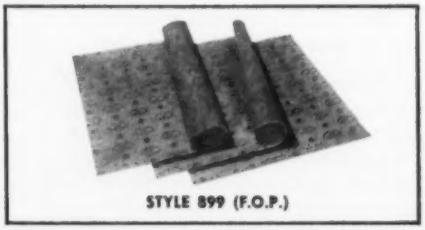
STYLE 125

STYLE 125—U. S. WIZARD ROUND BRAIDED ASBESTOS PACKING

For use in valve stems, reciprocating rods and plungers, against steam, air, hot and cold water, ammonia, oil, chemicals and some acids. Made of long fibre asbestos yarn, braided in round cross-section in the braid-over-braid construction, thoroughly lubricated and graphited throughout.

STYLE 899 (F.O.P.)—U. S. COMPRESSED ASBESTOS SHEET

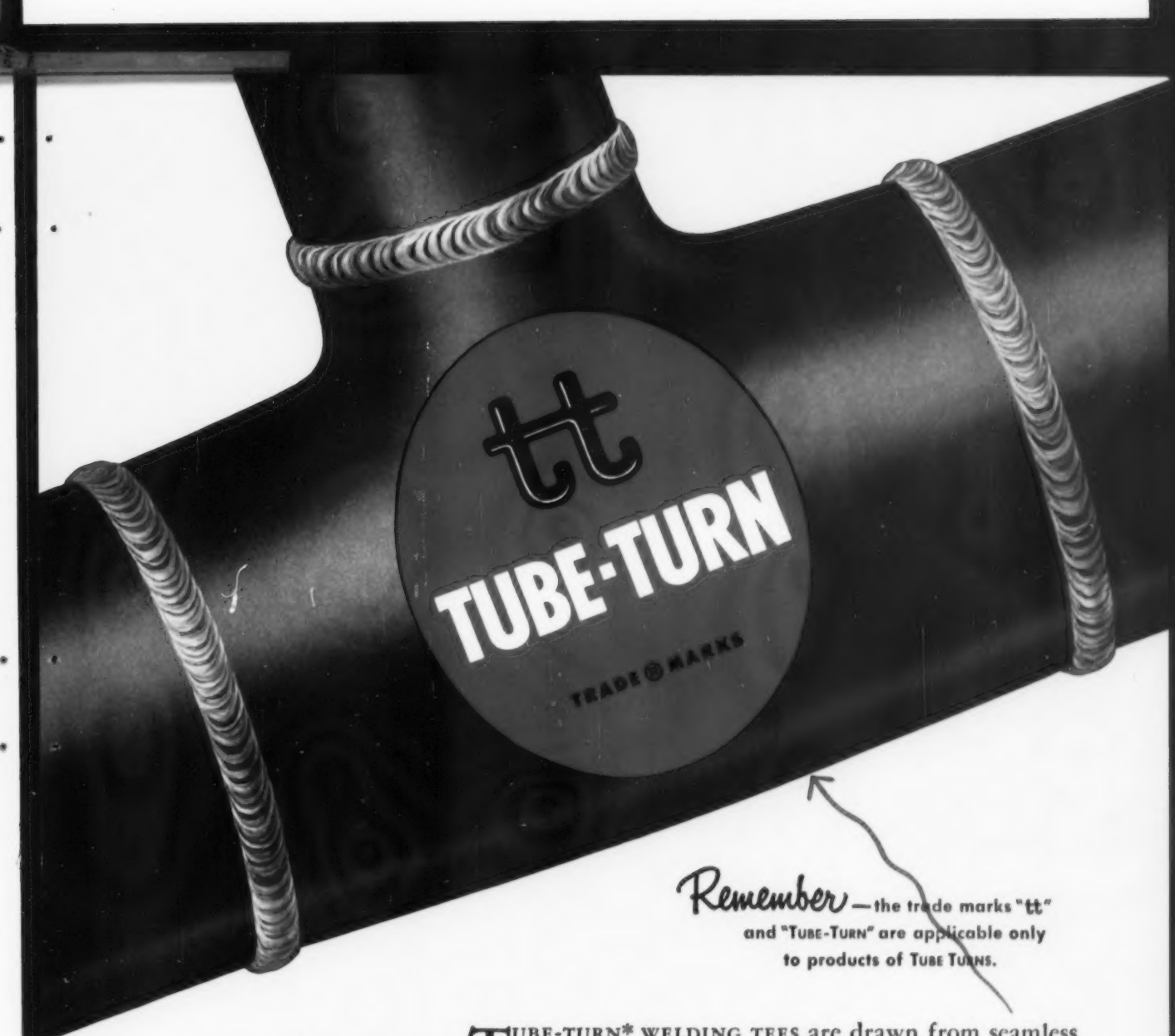
F.O.P. (Fibre Oil-Proof) is the original oil-proof asbestos fibre high-pressure sheet developed especially for oil industry conditions. Recommended for packing flanges or joints against superheated or saturated steam, air, ammonia, gases, oil, gasoline, water, some acids, alkaline solutions and other chemicals. Ideal for Still Head gaskets. It will not soften, burn, blow or ooze out of a joint, and does not deteriorate with age in stock.



STYLE 899 (F.O.P.)

US RUBBER **Mechanical Goods Division**

United States Rubber



Remember—the trade marks "tt" and "TUBE-TURN" are applicable only to products of TUBE TURNS.

You get extra strength with *The Leading Brand*

TUBE-TURN* WELDING TEES are drawn from seamless tubing to a barrel shape. This, and other design features produce high strength—averaging over 25% more than required by applicable standards.

Specify TUBE-TURN Welding Fittings and Flanges for extra values: superior products, the exact fitting or flange you need from our complete line, outstanding engineering service. Call your nearby Tube Turns' Distributor. He is at your service!

The Leading Manufacturer of Welding Fittings and Flanges

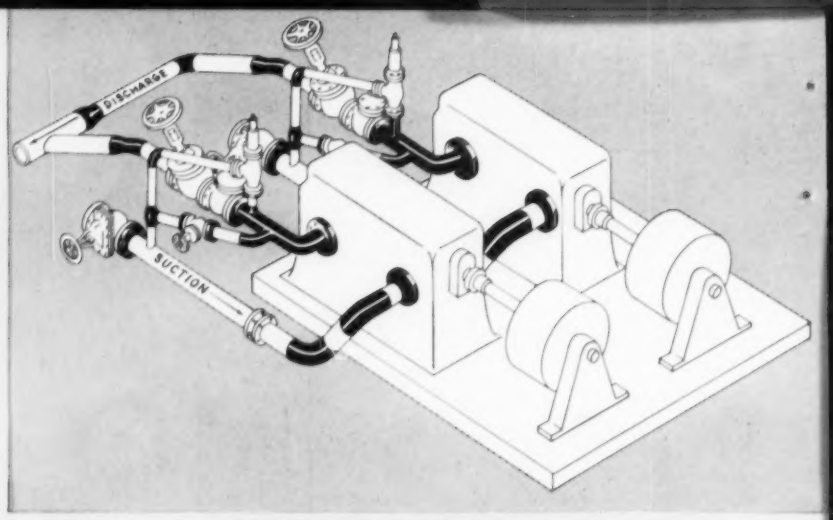
TUBE TURNS LOUISVILLE 1, KENTUCKY

A DIVISION OF NATIONAL CYLINDER GAS COMPANY

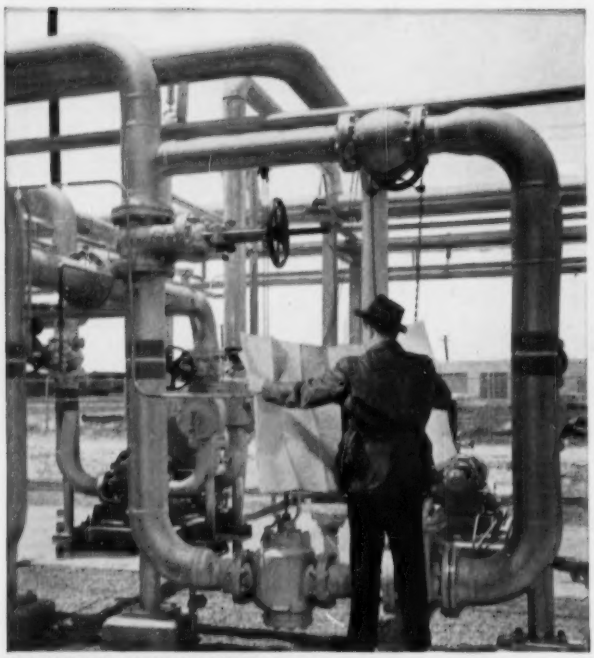
DISTRICT OFFICES: New York • Philadelphia • Cleveland • Toledo • Chicago • Denver • Los Angeles San Francisco • Seattle • Atlanta • Tulsa • Houston • Dallas • Midland, Texas

EXTRA VALUES

Speed up your piping jobs with TUBE TURNS' SERVICE



ENGINEERING SERVICE—Tube Turns' Engineering Service can help you on your piping projects. For example: Diagram above shows an application where TUBE-TURN* Welding Fittings and Flanges simplified the design and erection of pump piping. They save time, save space, and make the piping permanently leakproof and reliable. Ask your Tube Turns' Distributor to give you the pump piping recommendations of Engineering Service.



COMPLETE LINE SERVICE—You can *make sure* of getting the right fitting for each job when you specify "TUBE-TURN". This is the world's most complete line of welding fittings and flanges, including more than 4000 items, in all piping materials, schedules, and sizes.

AVAILABILITY—Your nearby Tube Turns' Distributor carries local stocks for fast delivery. Call him for good service in good connections.

Technical data service

Tube Turns is recognized as a leading source of authoritative information on piping design. For booklet on "Allowable Working Pressures", fill out and send the coupon now.

DISTRICT OFFICES

New York	San Francisco
Philadelphia	Seattle
Cleveland	Atlanta
Chicago	Tulsa
Denver	Houston
Los Angeles	Dallas
Midland, Texas	

TUBE TURNS, Dept. Y-5
224 East Broadway, Louisville 1, Kentucky

Please send free copy of "Allowable Working Pressures"

Company Name _____

Company Address _____

City _____ *Zone* ____ *State* _____

Your Name _____

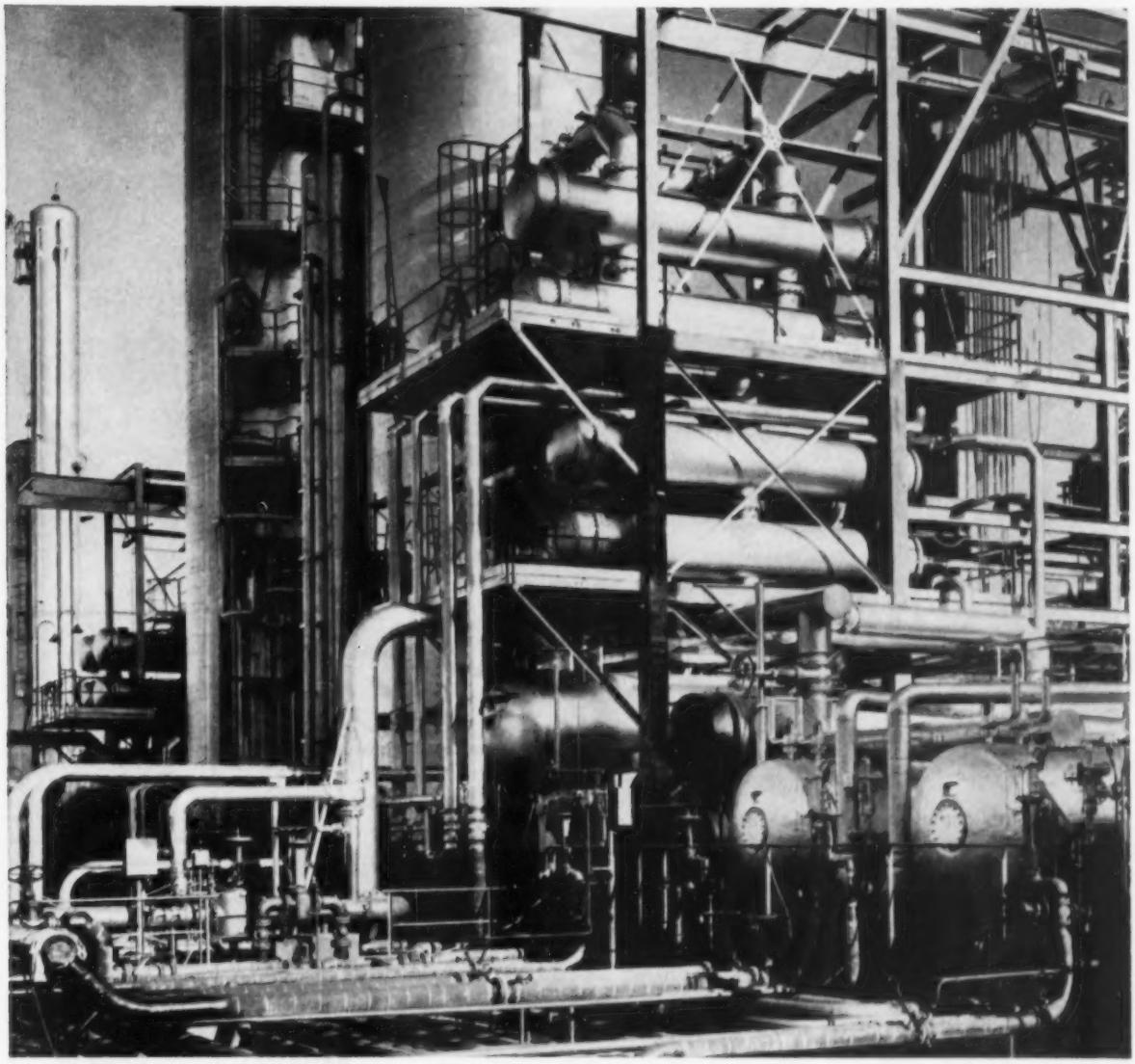
Position _____

* "tt" and "TUBE-TURN" Reg. U.S. Pat. Off.

TUBE TURNS

A DIVISION OF NATIONAL CYLINDER GAS COMPANY

LOUISVILLE 1, KENTUCKY



When temperatures and thruput go **UP**...

Carpenter Stainless Tubing holds corrosion costs **DOWN**

● Is the threat of rapid deterioration of tubing in heat exchangers and other process units keeping you from raising temperatures and increasing velocities?

Carpenter Stainless Tubing and Pipe have proven their ability to stand up under increased temperatures and thruput, with substantial cost reductions in material, labor and downtime.

Complete line of 14 standard AISI analyses and many other special alloy grades are available. Write for latest Selecting and Buying Guide . . . or contact your Carpenter Distributor now.

MEMBER

The Carpenter Steel Company
Alloy Tube Division, Union, N. J.

Export Dept.: The Carpenter Steel Co., Port Washington, N.Y.—"CARSTEELCO"

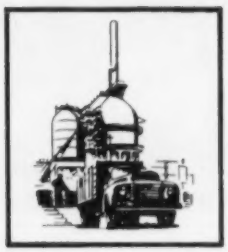
Carpenter

Stainless Tubing & Pipe

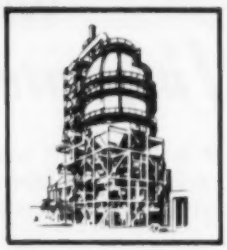
For more data on advertised products, use Readers' Service Cards, last page.

ONE SOURCE *for all Three*

ENGINEERING



MATERIALS



ERECTION SERVICE

If you are revamping or adding to the capacity of cat crackers, oil stills or heaters—you'll do better if you get a quote from Bigelow-Liptak on the refractories for the vessel or heat enclosures.

Why? Because B-L supplies all of the *three* elements which must be considered—engineering, materials, erection help.

Jobs are handled by engineers who *know* every facet of the problem at hand—men who have had years of experience with refractories and oil refinery problems. Materials used have been proven on countless installations under the most severe of abrasive or high temperature conditions. And erection is performed by a crew of men who specialize in refinery work . . . not only in the United States, but all over the world.

All in all, you can't miss. Cost? Less than you might think—particularly in the long run. Write today!

BIGELOW-LIPTAK *Corporation*

AND BIGELOW-LIPTAK EXPORT CORPORATION

2550 WEST GRAND BOULEVARD, DETROIT 8, MICHIGAN

UNIT-SUSPENDED WALLS AND ARCHES

In Canada: BIGELOW-LIPTAK OF CANADA, LTD., *Toronto, Ontario*

ATLANTA • BOSTON • BUFFALO • CHICAGO • CLEVELAND • DENVER • HOUSTON • KANSAS CITY, MO. • LOS ANGELES • MIAMI • MINNEAPOLIS • NEW YORK • PHILADELPHIA • PITTSBURGH • PORTLAND, ORE. • ST. LOUIS • ST. PAUL • SALT LAKE CITY • SAN FRANCISCO • SEATTLE • TULSA • MONTREAL • SAULT STE. MARIE, ONT. • VANCOUVER • WINNIPEG

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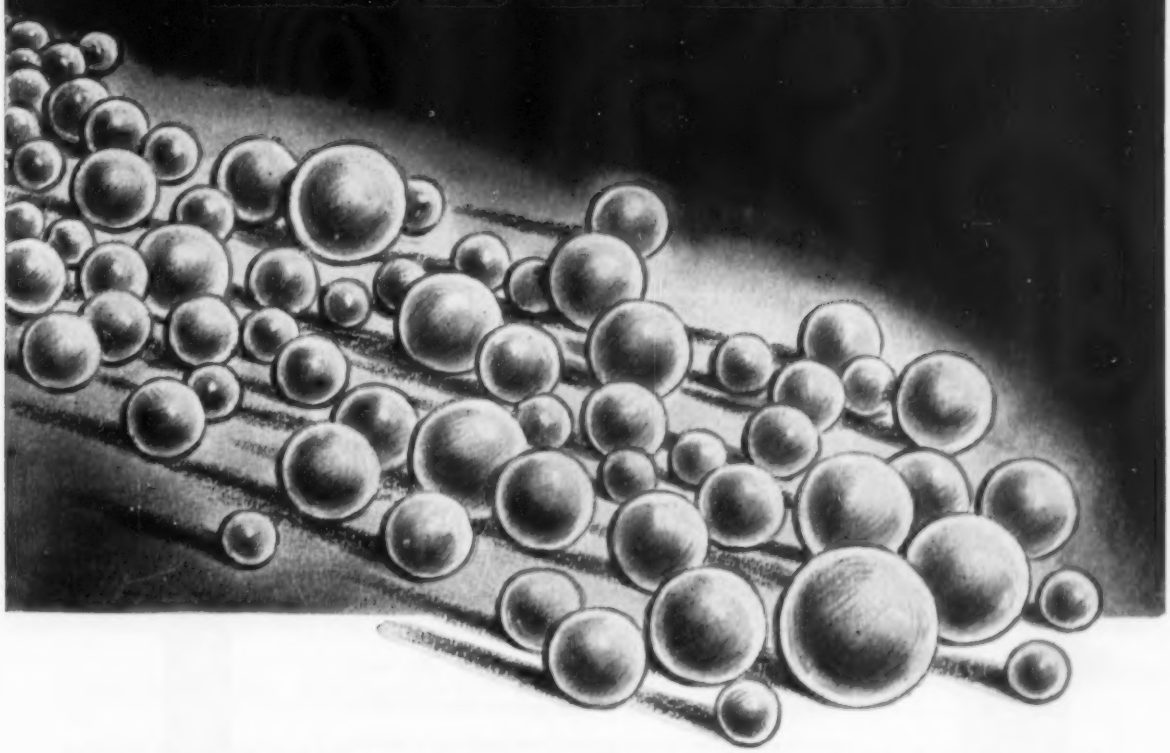
Ceramic Balls

FOR CATALYST SUPPORT, FOR PYROLYTIC REACTIONS AND AS MOVING BED HEAT TRANSFER MEDIA



As a heat transfer and catalyst support medium in various platinum catalyzed refining operations, "U.S." Ceramic Balls are proving unusually effective. They are being widely used for desulfurization processes and thermal cracking in fixed position or moving bed heaters.

"U.S." Ceramic Balls possess heat-shock resistance, superior thermal conductivity and high specific heat. Resistance to crushing is excellent, permitting successful operation with bed depths exceeding 50 feet. The material is thoroughly vitrified and is particularly recommended for its proven resistance to erosion and abrasion. Their complete chemical inertness makes them exceptionally useful where highly sensitive catalysts are involved.

The smooth surface and spherical shape of "U.S." Ceramic Balls have proven more efficient than irregularly sized and shaped heat transfer elements.

"U.S." Balls are available in two grades, both offering lower cost per unit volume: "Standard Body 57," and "Ceratherm-550" where unusual thermal-shock and heat resistance are required.

All sizes are available from ¼" O.D. to 3" O.D.

Chemical Ceramics Division

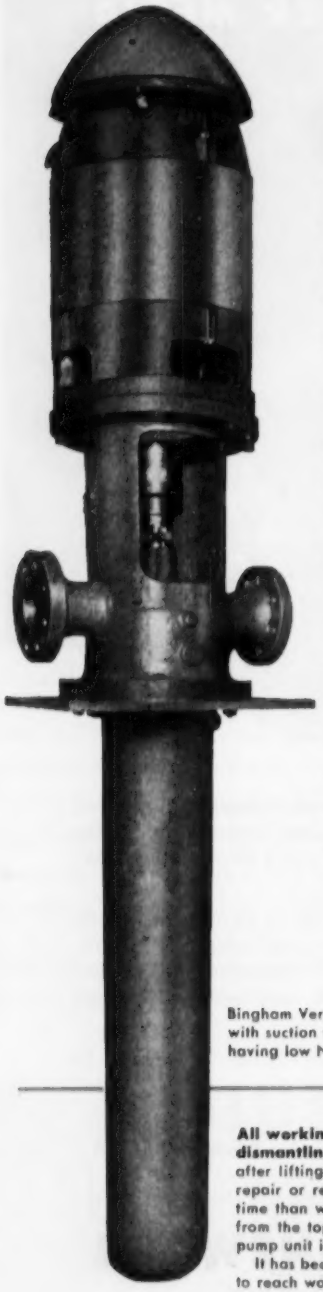
U. S. STONEWARE

AKRON 9, OHIO

326E

For more data on advertised products, use Readers' Service Cards, last page.

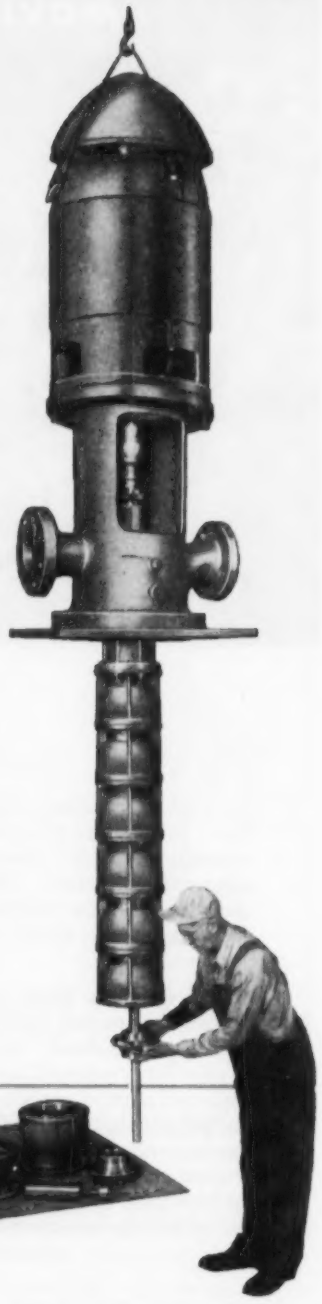
NEW! Bingham ALL WORKING PARTS



Besides bottom dismantling, which in itself greatly reduces maintenance time when attention is required, this new Bingham pump incorporates advanced design features which minimize maintenance, reducing the need for periodic inspection.

For example, all intermediate bearings (supplied of appropriate material for different pumpages) are forced-lubricated by the pumpage. Bottom bearing is lubricated even if the pump runs dry for short periods. This *dependable* lubrication greatly prolongs the life of bearings, which in conventional pumps are frequently the cause of maintenance shutdowns.

Wherever it has been installed, the new Bingham VCP Pump has given trouble-free service—plus unsurpassed smooth operation with no vibration. Available for any capacity or head. Write your nearest Bingham office for additional information, and Bulletin 109.

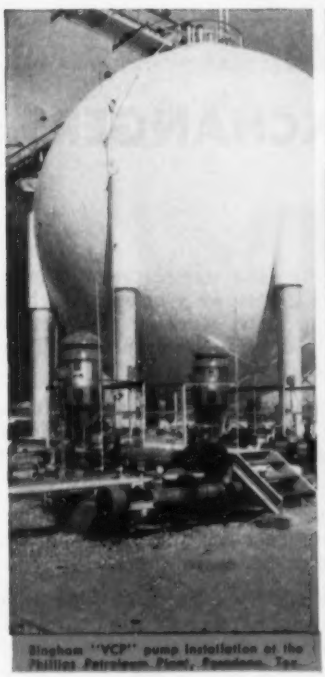


Bingham Vertical VCP assembled with suction well for installations having low NPSH conditions.

All working parts of pump easily accessible with bottom dismantling. One man can service the Bingham VCP Pump after lifting pump from well. By dismantling from the bottom, repair or replacement of any part can be made in much less time than with conventional pumps (where dismantling begins from the top, necessitating removal of driver and head before pump unit is accessible).

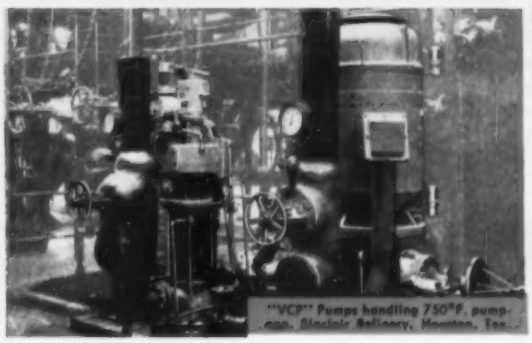
It has been estimated by various operators that time required to reach working parts has been reduced as much as 50%.

VCP VERTICAL PUMP FOR LOW NPSH
ACCESSIBLE WITH BOTTOM DISMANTLING

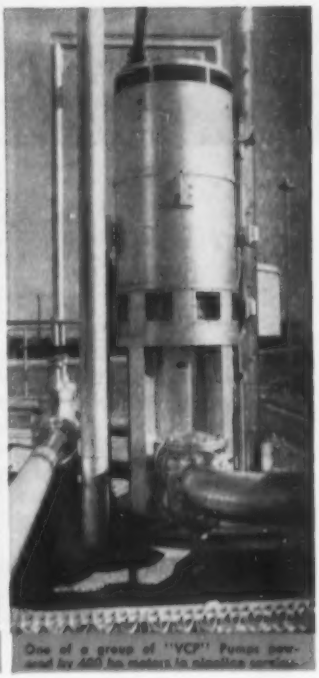


Bingham "VCP" pump installation at the Phillips Petroleum Plant, Pasadena, Tex.

Bingham Type "VCP" Pumps at the Champlin Refining Co., Enid, Okla.



"VCP" Pumps handling 750°F. pump-age, Pasadena Refinery, Houston, Tex.



One of a group of "VCP" Pumps pow-ered by 400 hp motors in pipeline service.

Partial list of major oil companies with Bingham "VCP" Pumps in operation or on order:

Ashland Oil & Refining Co.	Phillips Petroleum Co.	Chemical Construction Co.
Gulf Oil Corporation	American Cyanamide Co.	Champlin Refining Co.
Sinclair Oil & Refining Co.	ESSO-Standard Oil of N. J.	Pacific Gas & Electric Co.
Sun Oil Company	British American Oil Co., Ltd.	Socony-Vacuum
The Texas Company	Lakehead Pipe Line Co.	Aerojet General Corp.
Imperial Oil Co., Ltd.	Creole Petroleum Co.	Great Lakes Pipe Line Co.
Shell Oil Company	Humble Oil Company	Kaneb Pipe Line
Deere & Company	Standard Oil Co. of Indiana	Buckeye Pipe Line Co.

Bingham SINCE 1921

DOUBLE VOLUTE PUMPS RADIAL BALANCE

BINGHAM PUMP COMPANY
General Offices: 2800 N.W. Front Avenue, Portland 10, Oregon
Factories: Portland, Ore. • Vancouver, B. C., Canada

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PITTSBURGH, PA.
SAN FRANCISCO, CALIF.
SEATTLE, WASH.
ST. LOUIS, MO.
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For more data on advertised products, use Readers' Service Cards, last page.

TECHNIQUES *and* TOOLS

MAKE THE DIFFERENCE IN WESTERN HEAT EXCHANGERS

The manufacture of Western heat transfer equipment is characterized by two important factors: (1) employing the latest and best data available in establishing the actual needs of our customers quickly and accurately; (2) employing the same care and attention to detail in the fabrication of the equipment required.
Western Supply Company renders a *complete service* to each customer — research, design, engineering and fabrication — resulting in equipment of exceptional quality at a fair price, and built for long-life economy.
Your heat transfer requirements — present or future — deserve the attention of Western *specialists* in this field. We'll appreciate your inquiry.

In the *thermal rating* of heat transfer requirements, Western engineers have developed a technique which is actually a *consulting service,* working closely with customers to arrive at the best and simplest solution of their needs.

Thus, each Western exchanger is sized to give the most economical unit for the job, and reflects the experience gained in working equally closely with other customers with similar problems.

The Western "technique" also recognizes the importance of completing your heat exchanger file quickly, thereby allowing you to proceed with other operations.

For instance, when standard floating head, U-tube or fixed tube sheet exchangers are ordered from Western, you can depend on receiving drawings *within 7 to 10 days,* enabling you to proceed with piping and foundation drawings immediately.

In the fabricating stage, Western uses only the most modern production tools and equipment, assuring the utmost in production control in the building of your heat exchangers. Such quality controls as controlled torque tube rolling, weld x-ray, Magnafluxing and hydrostatic testing assure the consistent high standard of Western exchangers.

ASME code standards represent the *minimum* requirement for Western heat exchangers, but on *each* unit, Western builds the *best heat exchanger possible.*

Thus, in the instance of careful tube hole preparation and controlled torque tube rolling, a given Western Exchanger can be retubed more often for greater savings for our customers, because of these high standards of production.

Techniques and tools *do* make a difference in thermal and mechanical design — and the difference is in your favor at Western!

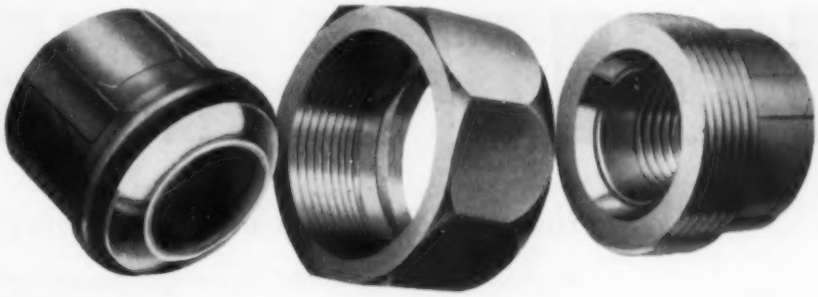
WESTERN HEAT EXCHANGERS

WESTERN SUPPLY COMPANY
P. O. BOX 1888 • TULSA, OKLAHOMA

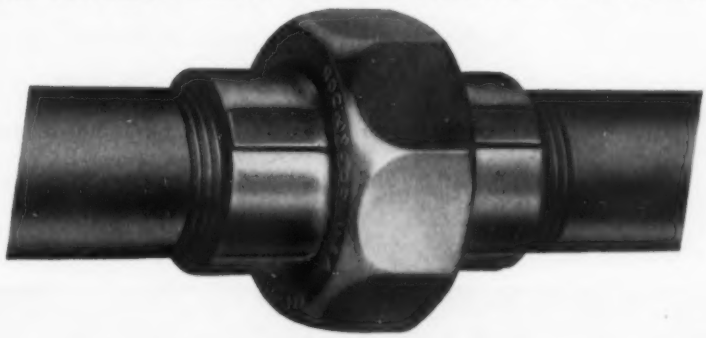
HUDSON-RUSH COMPANY — 753 Gladstone Blvd., Shreveport, La.
130 Casa Linda Plaza, Dallas, 18, Tex.
P. O. Box 3151, Amarillo, Tex.

PROCESS INSTRUMENTS & EQUIPMENT CO. — North Bldg., Charleston, W. Va.

H. W. SEVERANCE — 2416 Frankfort Ave., Louisville, Ky.



Because the male seat
is 150 Brinell harder than .....the female seat.....



Rockwood unions will not gall when making up!

HARDNESS DIFFERENTIAL

makes the big difference. This exclusive Rockwood feature means this #603 union will perform better and last longer . . . making a really trouble-free joint.

COMPLETE INTERCHANGEABILITY — Even under difficult working conditions, Rockwood Union #603 gives you superior performance. And each part of the #603 is interchangeable.

EXCLUSIVE "ROCKWOODIZING" — There's another big difference that pays off, too! That's exclusive "Rockwoodizing" process that protects the entire Union including threads, against corrosion. Add these big advantages to the fact that both seats are made of corrosion-resistant AISI molychrome steel, forged in place and bonded-locked under 100,000 and 400,000 pound pressure and you'll know why you can't buy a better Union.

ROCKWOOD SPRINKLER COMPANY

Distributors in all principal industrial areas

GET ALL THE FACTS on the Rockwood Union #603, mail coupon now.

ROCKWOOD

ROCKWOOD SPRINKLER COMPANY
1464 Harlew Street
Worcester 5, Mass.

Please send me prices and further data on the new Rockwood Union #603. I would also like the name of the nearest Rockwood distributor.

Name.....

Title.....

Company.....

City.....Zone..State.....

For more data on advertised products, use Readers' Service Cards, last page.

KUPLEX

the new Tretolite metal deactivator

Kuplex deactivates harmful copper and copper compounds by a chelating action. This prevents hydrocarbon deterioration caused by metal catalyzed oxidation. Kuplex prevents the undesirable reactions by combining with the dissolved copper to form a stable chelate. If copper is present, the use of Kuplex will reduce the amount of anti-oxidant necessary to effect desired stability.

Kuplex can be effectively used to deactivate copper in hydrocarbons such as

GASOLINE • KEROSINE
JET FUEL • DIESEL OIL
FURNACE OIL • TURBINE OIL

Kuplex effectively protects the quality of hydrocarbon products for as little as 2 mills per barrel. This insurance against customer dissatisfaction is worth many times its low cost.

For complete technical data, samples and prices, ask your Tretolite refinery service engineer or write to

TRETOLITE COMPANY

A DIVISION OF PETROLITE CORPORATION

369 Marshall Avenue, St. Louis 19, Missouri
5515 Telegraph Road, Los Angeles 22, California

chemicals and services for the petroleum industry

Desalting • Demulsifying • Corrosion Preventives • Scale Inhibiting Asphalt Additives • Fuel Oil Additives • Water De-oiling • Paraffin Removal • Production Stimulation • Bactericides • Metal Conditioners

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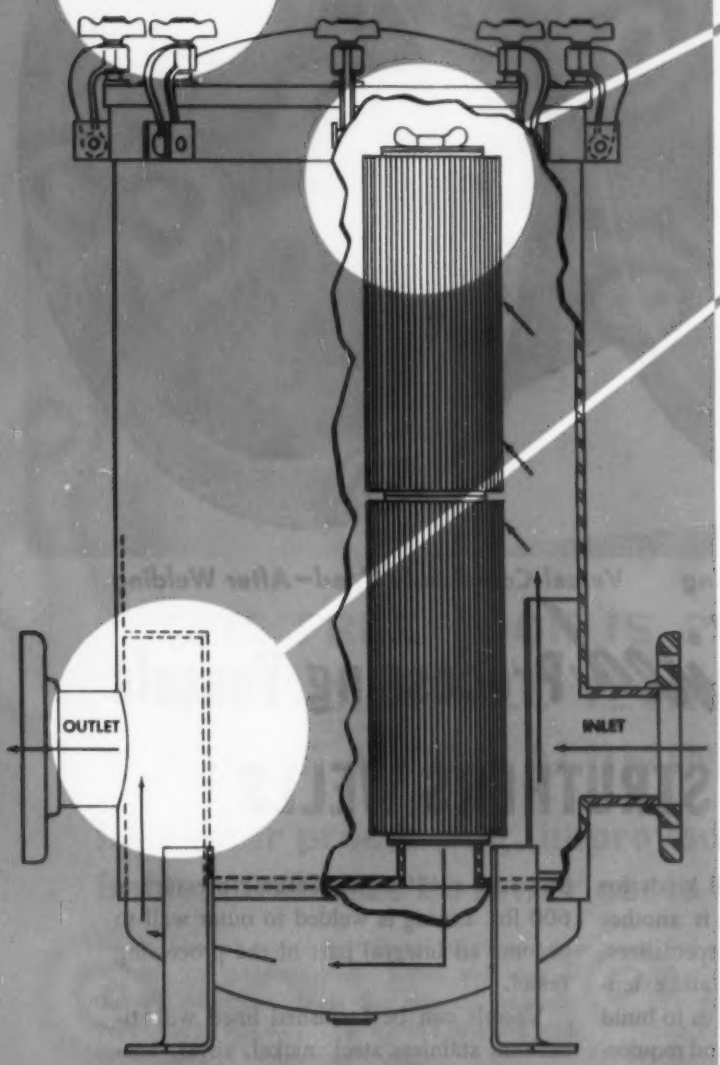
NOW! In ONE Filter



Easy Servicing

Just a twist of the wrist and the top swings open. No special tools needed; eliminates nuts and bolts; no busted knuckles.

Best Performance

PETROLEUM MARKETING FACILITIES: truck loading racks, aircraft fueling, fuel oil bulk plants.

MACHINE TOOLS: coolants and cutting oils, hydraulic oils.

INDUSTRIAL PLANTS: solvents, oils, water and other non-corrosive fluids.

WITH THE

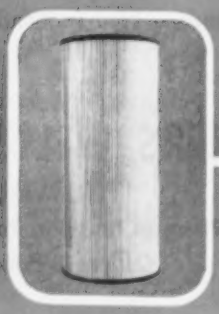
New Excel-So

57 SERIES FILTERS

Check these advantages • Simplified construction—low initial cost • Reduced size for compact installation • Quick opening cover and provision for instantaneous cartridge change • Improved filtration efficiency and greater dirt holding capacity . . . result . . . low cost maintenance • Very low initial pressure drop • Available for vertical or horizontal installation • Location of inlet and outlet connections to customer specifications • Wide range of product applications • Units in standard design or for code requirements • Non-ferrous construction available • Extra accessories including air eliminator, pressure gage, dump valve, etc., available.

WARNER LEWIS COMPANY

BOX 3096 • TULSA, OKLAHOMA



CH-57PL
PLEATED CARTRIDGE

THE NEWLY Developed
CH-57PL Cartridge combines

- Larger Outside Diameter
- Larger Inside Diameter
- Greater Height

RESULT

- More Filtration Surface
- Lower Operating Cost
- Higher Flow Rates

DIVISION OF **FRAM** CORPORATION
Representatives in all major cities
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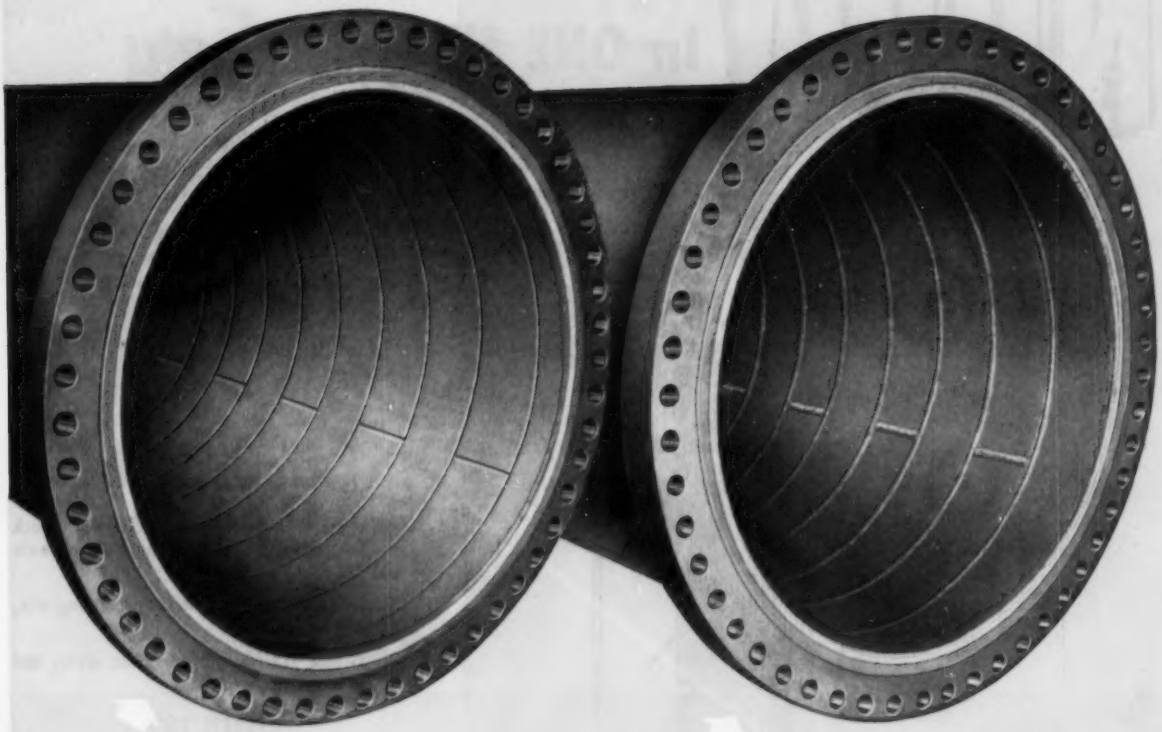
Write for bulletin WL-6-56



Lining Fitted—Before Welding *Vessel Completely Lined—After Welding*

For Special *Lined* Processing Vessels Come to STRUTHERS WELLS

LINING processing vessels of all kinds for chemical plants and refineries is another service in which Struthers Wells specializes. Years of engineering experience and extensive fabricating facilities enable us to build lined vessels that meet all codes and requirements.

The vessel illustrated is Inconel-lined, 36″ I.D. x 43′ high. Working pressure is 600 lbs. Lining is welded to outer wall to become an integral part of the processing vessel.

Vessels can be furnished lined with titanium, stainless steel, nickel, silver, hastelloy and other weldable metals to suit your applications.

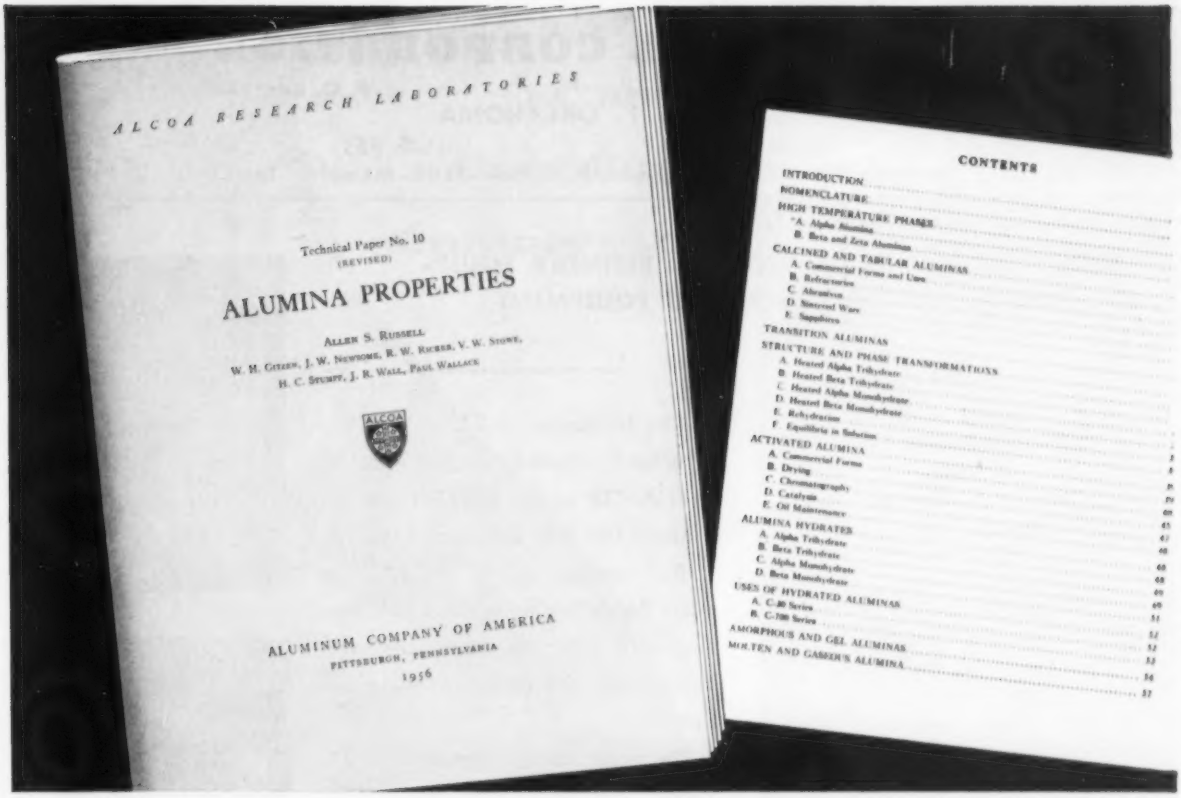
Struthers Wells

STRUTHERS WELLS CORPORATION

TITUSVILLE, PA.

Plants at Titusville, Pa. and Warren, Pa.

Offices in Principal Cities



THIS FREE BOOK IS PACKED WITH VALUABLE TECHNICAL DATA ABOUT ALCOA ALUMINAS

for faster processing, improved chemical reactions, better products at lower costs

Here is the most complete technical reference work available on the commercial forms and uses of ALCOA® Aluminas. It is the manual, *Alumina Properties*, by ALCOA . . . the world's first and leading producer of commercial aluminas.

ALCOA traces the development of the commercial varieties of alumina with detailed data on their occurrence in nature; preparation; crystal structure; optical, thermal, electrical, magnetic, mechanical and surface properties. The applications of each are explored in full with relation to their properties.

This valuable book in your files will give you ready reference to the many ways ALCOA Aluminas can serve you . . . as catalysts, desiccants, bed supports and covers, fillers and in a host of other uses . . . to speed processing, improve chemical reactions, create better products at lower cost. You will have at your fingertips ALCOA's unparalleled experience and research in the field of aluminum chemicals.

To get your free copy of this 65-page book, write on your company letterhead for *Alumina Properties*. Address ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 717-J Alcoa Building, Pittsburgh 19, Pennsylvania.

ALCOA CHEMICALS
ALUMINUM COMPANY OF AMERICA

THE ALCOA HOUR
TELEVISION'S FINEST LIVE DRAMA
ALTERNATE SUNDAY EVENINGS

For more data on advertised products, use Readers' Service Cards, last page.

FLINT STEEL CORPORATION

1624 W. 21 St. P. O. Box 1289

TULSA 1, OKLAHOMA

Phone LU 4-1441 L.D. 551

Memphis Plant: Columbia Road, P. O. Box 3155, Memphis, Tenn.

Designers and Fabricators of:

GASOLINE PLANT EQUIPMENT, OIL REFINERY EQUIPMENT AND CHEMICAL PROCESSING EQUIPMENT

PRODUCTS

Absorbers
After-Coolers
Air Tanks
Anhydrous Ammonia Storage Tanks
Bubble Caps
Bubble Trays
Bubble Towers
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Condenser Boxes
Depheigmators
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Fractionating Columns
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Heat Exchangers
L.P. Gas Storage Tanks
Mist Extractors
Natural Gasoline Plants
Preheaters
Pressure Storage Tanks
Pressure Vessels
Reboilers
Stabilizers
Steam Superheaters
Reinforcing Structural Steel and Bars
Steel Stacks
Storage Tank Heaters
Warehouse Steel
Welded Steel Tanks

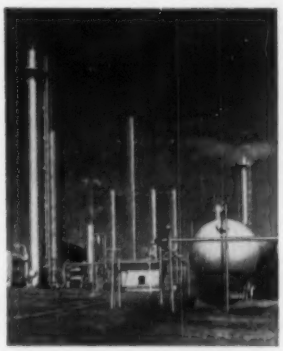
The fabrication of TULSA TYPE Process Equipment complies with the API-ASME or the ASME Code for Unfired Pressure Vessels as required.

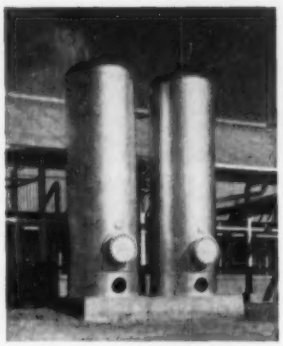
Roll capacity is 1¾" or 2" thick plate depending upon the width and diameter. Flint is equipped with radiograph and stress relieving facilities.

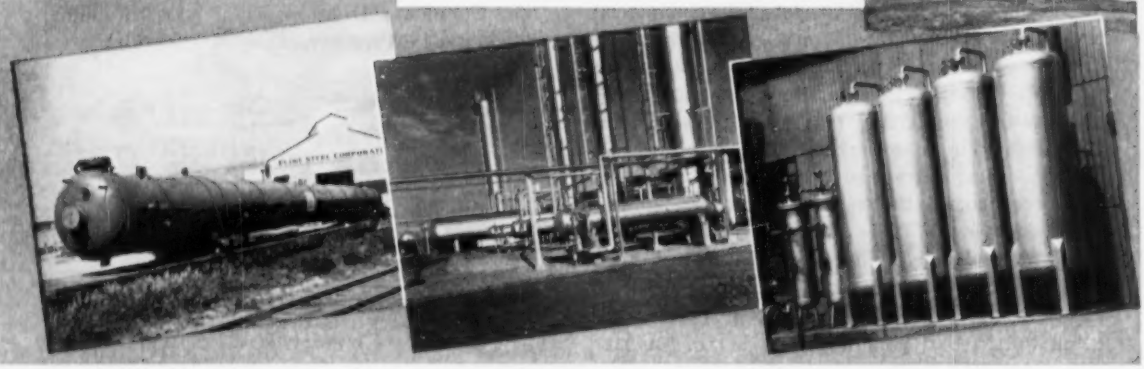
The stress relieving furnace is 15' 2" wide by 85' long, so designed it will stress relieve a vessel 150' long. Bubble towers up to 13' 5" diameter by 150' long have been shipped in one piece.

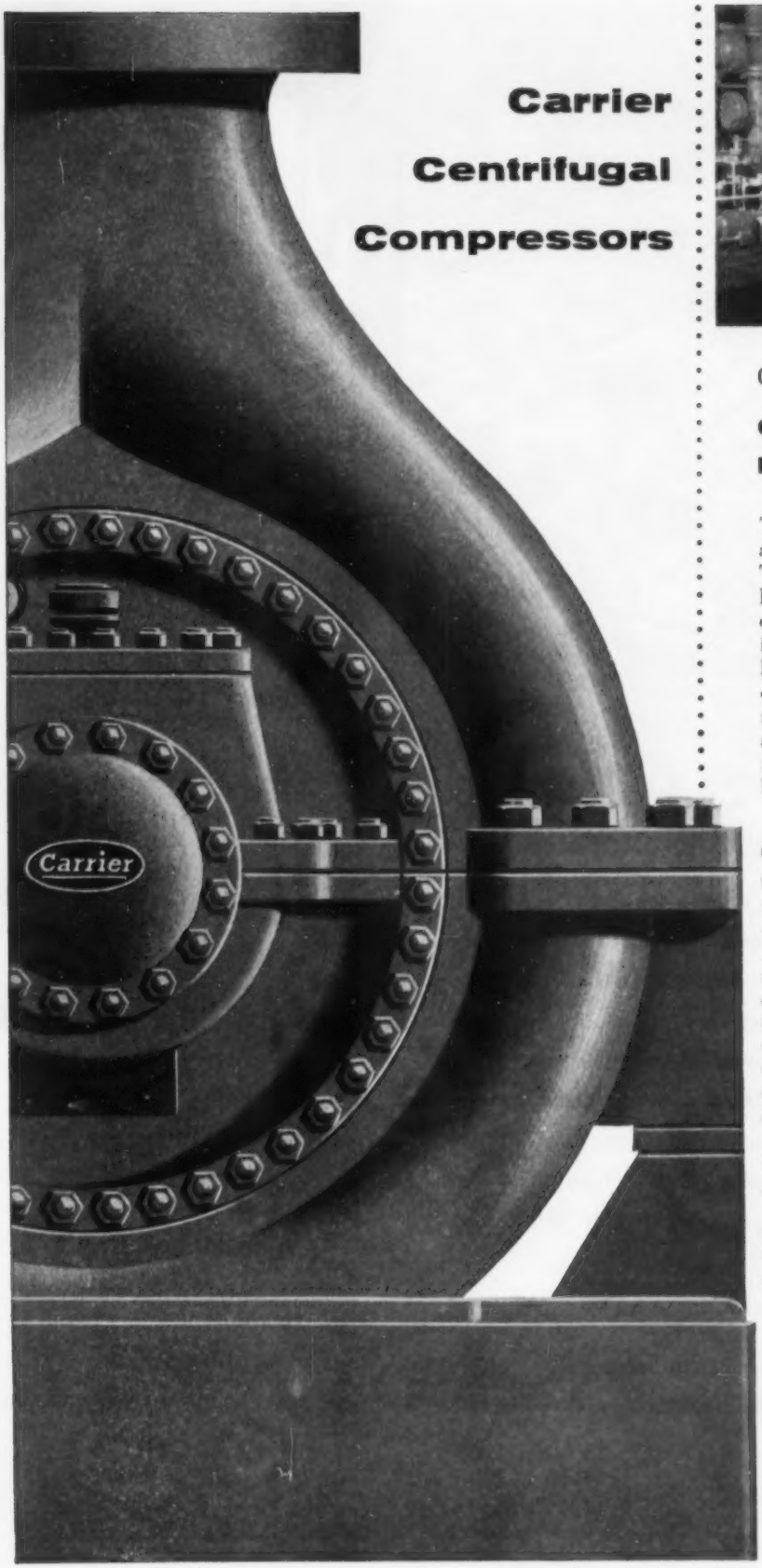
The manufacturing facilities of the two Plate Shops with their machinery and equipment make Flint one of the largest fabricators of steel plate products for the Processing Industries in the country.

FABRICATED STEEL PLATE • FABRICATED STRUCTURAL STEEL • FABRICATED GALVANIZED STEEL • FABRICATED REINFORCING STEEL • STEEL WAREHOUSE

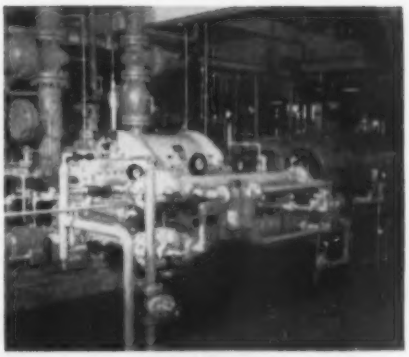








Carrier Centrifugal Compressors



on the job at

Canadian Petrofina Limited

Two Carrier Centrifugal Compressors are on the job at the Pointe aux Trembles plant of Canadian Petrofina Limited. One of the two 800-hp machines serves as a recycle compressor in the production of high-octane gasoline from low-grade naphtha. The other compresses hydrocarbon vapors released from the reactor during the alkylation process and plays a vital role in producing gasoline of very-high-octane rating.

Carrier makes a complete line of centrifugal and axial flow compressors for gas compression and refrigeration—up to 10,000 hp in a single unit. Hundreds of these dependable Carrier machines are on the job at dozens of chemical plants and refineries across the country—such as Olin Mathieson Chemical Corporation, Standard Oil Company of California, Wyandotte Chemicals Corporation, The Texas Company. May we assist you?

If you'd like a copy of our booklet, **"Centrifugal Compressors for Industry,"** please call your nearest Carrier office. Or write Carrier Corporation, Syracuse, New York.

Carrier

centrifugal compressors
refrigerating equipment

For more data on advertised products, use Readers' Service Cards, last page.

These unique fittings provide substantial economies, because their simple construction and high degree of interchangeability permit considerably less inventory than conventional fittings of their type.

With two series available of nine fittings each, the 18 fittings contain only 26 parts instead of the conventional 72.

Let us show you how new Key 5000 Type Fittings can serve you more efficiently and economically. Write today for complete information.

- **simpler construction**
- **higher interchangeability**
- **lower inventories**

W-K-M MANUFACTURING COMPANY, INC.
A SUBSIDIARY OF acf INDUSTRIES INCORPORATED
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W-K-M THROUGH-CONDUIT GATE VALVES

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"Personally,
I always specify
LEWIN-MATHES
Condenser Tube"

Lewin-Mathes welcomes stiff-necked specifications.

We meet them... because, as COPPER REFINERS, we control the exact composition of every alloy billet we form into condenser tube.

We meet them . . . because, as FABRICATORS, we control every step in the manufacture of Lewin-Mathes Condenser Tube from *raw material to finished product.*

We meet them . . . because, as INTEGRATED SPECIALISTS, we take pride in delivering every foot of Lewin-Mathes Condenser Tube uniform and perfect . . . "tailor-made" to perform better under *your* specific operating conditions.

Lewin-Mathes' mastery over every physical and chemical property of Heat Exchanger Tube can mean important savings for you. Bring your condenser tubing problems to us and see!

Nothing primitive about Lewin-Mathes service facilities. Expert technical and engineering assistance is available to you through 25 strategically-located Branch Offices.

LEWIN MATHES
SAINT LOUIS, MISSOURI
CUPRO-NICKEL CONDENSER TUBE
COPPER AND BRASS TUBE, PIPE AND ROD

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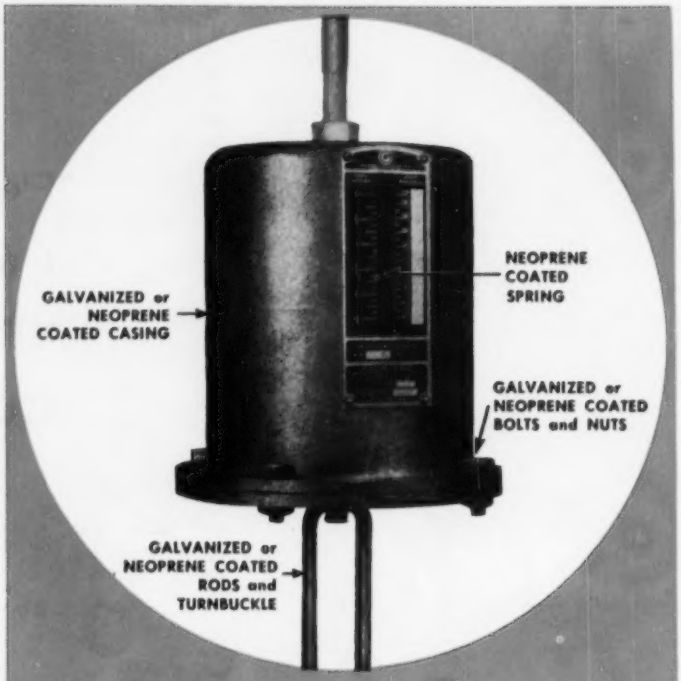
NEW

weather-resistant, corrosion-resistant

GRINNELL VARIABLE SPRING HANGERS...


GALVANIZED or NEOPRENE COATED CASING
NEOPRENE COATED SPRING
GALVANIZED or NEOPRENE COATED BOLTS and NUTS
GALVANIZED or NEOPRENE COATED RODS and TURNBUCKLE

Another Grinnell First!

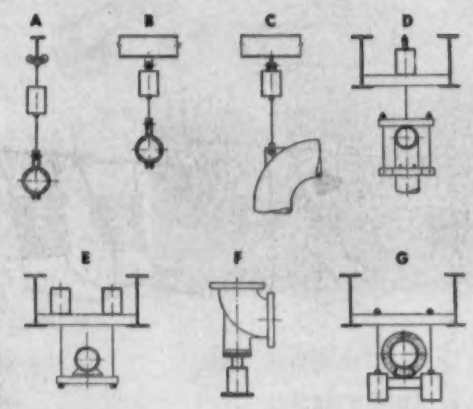
Grinnell pre-engineered spring hangers are now offered in two new lines to meet the need for spring hangers in installations subject to highly corrosive industrial conditions and to severe weather exposure.

These hangers are the result of extensive experimentation with various coatings for Grinnell's standard pre-engineered spring hangers. In addition to providing flexibility in pipe suspension, they provide versatility of application through their corrosion-resistant characteristics. They are . . .

1. Neoprene coated — for highly corrosive conditions such as those found in chemical plants and refineries. *All* parts of the hanger are neoprene coated to protect the base metal from a wide range of corrosives. The flex life of the spring is unaffected by the neoprene . . . the coating resists cracking or flaking over a wide temperature range.

2. Galvanized — for outdoor installations where weather conditions are severe. All parts of the hanger are galvanized except the spring, which is neoprene coated to avoid alteration of temper, hydrogen embrittlement and decreased flex-life of the spring — usual hazards to springs from the galvanizing process.

AVAILABLE IN 7 TYPES FOR THESE TYPICAL APPLICATIONS



(A) Rod threaded to top cap (B) Furnished with single lug (C) Two lug style (D) Top adjusting (E) Adjustable top and bottom (F) For floor support (G) Trapeze assembly.

Along with the obvious advantages of such corrosion and weather-resistant characteristics, consider these features . . .

- Maximum variation in supporting force per ½" of deflection is 10½% of rated capacity — in all sizes.
- Precompression* assures operation of spring within its proper working range, as well as saving valuable erection time. Reduced over-all height saves space.
- 18 sizes available from stock for load ranges from 53 lbs. to 12,000 lbs.
- Available in 3 spring lengths for travel ranges of 1¼, 2½, and 5 inches.
- Installation is simplified by integral load scale and travel indicators.

**Precompression is a patented feature.*

GRINNELL

AMERICA'S #1 SUPPLIER OF PIPE HANGERS AND SUPPORTS

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

For more data on advertised products, use Readers' Service Cards, last page.

The Mail Box . . .

Which Method?

To The Editor:

Francis W. Winn is to be commended for the detailed presentation of his project evaluation methods presented in your July article, "How to Invest Your Capital for Profits."

It appears that his method is essentially one of computing the difference between value and cost. Seems to me that a much more effective statistic, especially in situations where capital supply is limited, would be the value-cost ratio. This is a dimensionless number and as such it has the inherent advantages of such numbers for making valid comparisons.

I am interested in learning of other reader's comment as to the relative effectiveness of these two methods.

A. O. Smith Corp.,
Milwaukee, Wis.

D. H. Bein, Director
Economics and Mathematics

Careful Reader

To the Editor:

In your May issue, there is a box on page 223 ("A Better Ash Determination" by West, Suter and Perkins) which says, "Check these references to see how the Intercomplex Salts may be prepared." It then refers to various references. Looking in the bibliography, we discover that No. 21 is the last one listed; were the others left out by mistake?

If you can supply us with the information necessary to identify the articles, we will appreciate it.

L. E. Kohler, Librarian
U. S. Naval Engineering
Experiment Station
Annapolis, Md.

Editor's Note: Yes, the references were left out by mistake. We're happy to print them below. Other readers doubtless will be interested in the same listings.

[22] Welcher, F. J., *Organic Analytical Reagents*, New York: D. Van Nostrand Co., 1947, I, p. 286.
[23] Welcher, F. J., Ibid., I, 308.
[24] Welcher, F. J., Ibid., I, 305.
[25] Welcher, F. J., Ibid., I, 307.
[26] Welcher, F. J., Ibid., I, 297.
[27] Welcher, F. J., Ibid., III, 242.
[28] Welcher, F. J., Ibid., III, 262.
[29] Welcher, F. J., Ibid., III, 267.
[30] Welcher, F. J., Ibid., III, 176.
[31] Urbain, G., and Debierne, A., *Compt. rend.*, **129**, 302-5 (1899).
[32] Combes, A., *Compt. rend.*, **105**, 868-72 (1887).
[33] Gach, F., *Monatsh.*, **21**, 98-117 (1900).
[34] Thorpe, J. F., and Whiteley, M. A., *Thorpe's Dictionary of Applied Chemistry*, Fourth Edition.

Safety for an aircraft test facility at Pratt & Whitney Aircraft Plant, using BS&B Model DV Rupture Discs.

BS&B SAFETY HEADS

Now Handle Even "Tougher" Applications With The New Model DV Rupture Disc . . .

FEATURES OF THE MODEL DV DISC

- ✔ Unrestricted, Instantaneous Opening In Sizes 1" Through 36".
- ✔ Greater Safety – Operates Closer To Disc Rupture Pressure.
- ✔ Minimizes Metal Creep Due To Elevated Temperatures And Pressures.
- ✔ Pressure Ratings: 5 lbs. To Several Hundred Pounds.
- ✔ Temperature Ranges: Sub-Zero To 900° F.

- High Temperature
- Alternating Pressure and Vacuum
- Cycling
- Corrosive Service

USE BS&B SAFETY HEADS!

Utilize Our Research Facilities In Selecting Model DV Discs For "Tough" Applications.

BLACK, SIVALLS & BRYSON, INC.
Safety Head Division, Dept. 2-F9
7500 East 12th Street Kansas City 26, Missouri

BS&B — Another Example of Product Leadership

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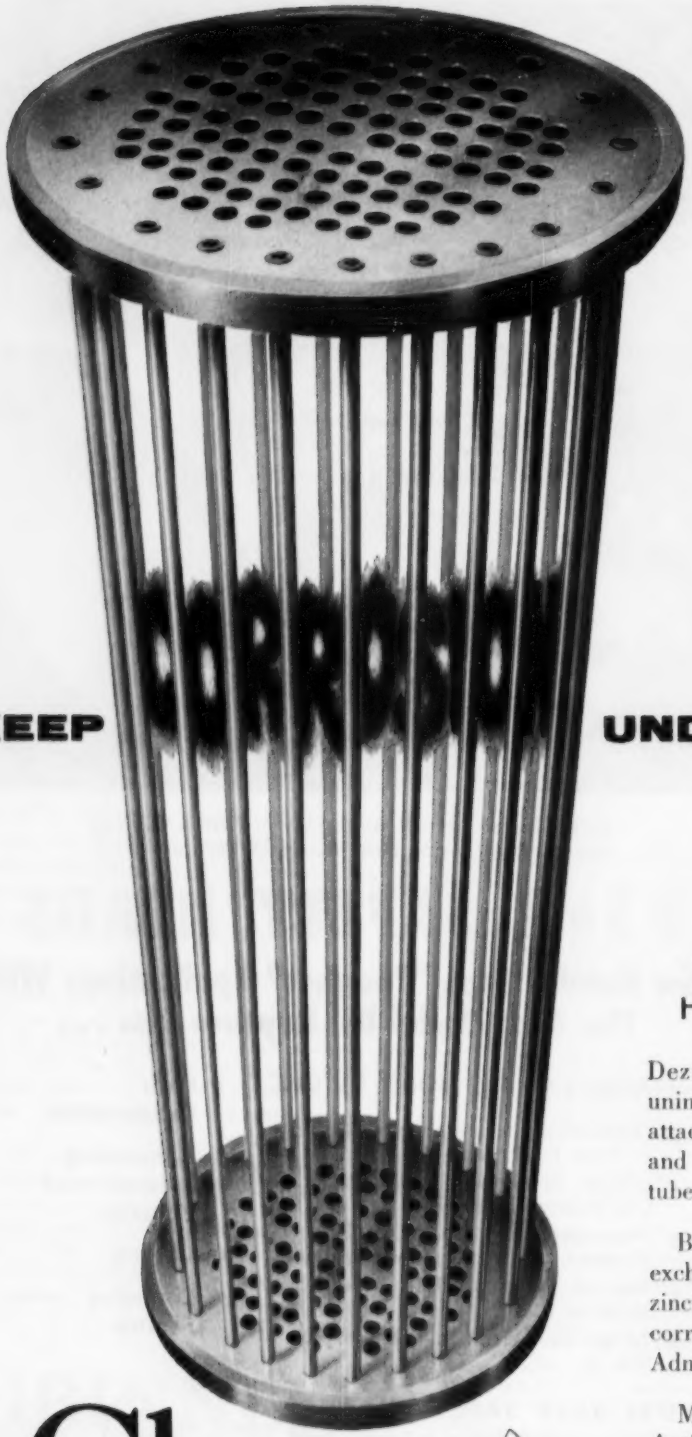

KEEP CORROSION UNDER CONTROL...

with CHASE® Antimonial Admiralty Heat Exchanger Tubes!

Dezincification can make short work of uninhibited condenser tubes! It insidiously attacks the metal surface, dissolving the zinc and leaving porous copper behind until the tube wall is completely penetrated.

But Chase Antimonial Admiralty heat exchanger tube is practically immune to dezincification! What's more, it retains *all* the corrosion resistant properties of ordinary Admiralty.

More than 100 million pounds of Chase Antimonial Admiralty tube have been installed to successfully combat dezincification, since Chase introduced this remarkable alloy in 1935. It may be just the alloy for you, too! Write for complete details.

Chase®
BRASS & COPPER CO.
SUBSIDIARY OF KENNECOTT COPPER CORPORATION • WATERBURY 20, CONNECTICUT

The Nation's Headquarters for Brass, Copper and Stainless Steel

Atlanta Baltimore Boston Charlotte Chicago Cincinnati Cleveland Dallas Denver Detroit Grand Rapids Houston Indianapolis Kansas City, Mo. Los Angeles Milwaukee Minneapolis Newark New Orleans New York Philadelphia Pittsburgh Providence Rochester St. Louis San Francisco Seattle Waterbury

For more data on advertised products, use Readers' Service Cards, last page.

The Mail Box . . .

London: Longmans, Green and Co., 1943, VI, p. 161.

[2] Morrow, C. A., and Sandstrom, W. M., *Biochemical Laboratory Methods for Students of the Biological Sciences*. New York: John Wiley and Sons, 1935, p. 281.

Excellent Survey

To the Editor:

Thank you very much for the reprint of the Article "Employing the College Graduate." It is very helpful in a number of ways.

I appreciate especially the questions and answers on the back page. I am going to clip the one about the most common faults of college placement departments and place it where it is a constant reminder of the things I should not do!

This is an excellent survey and you are to be commended for it.

Flora Marie Meredith
Office of Placement Services
Tennessee State College
Johnson City, Tenn.

In Explanation

As evidence of the close and careful readership PETROLEUM REFINER receives we are being questioned about the meaning of a certain abbreviation used in William E. Tuckers article "Want Refinery Costs Quickly?" that appeared in the August, 1956 issue. The particular culprit was "f.a.s."

"F.a.s." as used by Tucker simply means—"free alongside ship." In other words, all charges have been paid to place the goods "free" alongside the ship at the port of embarkation. This is the true value of the goods before any longshoreman charges, duty or handling charges are applied. —The Editors

Letters discussing timely topics of interest to PETROLEUM REFINER readers are invited. The editors are always happy to get views and observations from our readers and, likewise, our readers generally like to find out what the other fellow is thinking.

Up she goes!...at Sinclair's new UDEX Plant built by Badger Manufacturing Company.

42-ton stripper...by Downingtown

Diameter: 6′ I.D. • Total Height: 133′ 3″ • Shell Thickness: ¾″
Material: Carbon Steel • Total Weight: 42 tons • 40 Bubble Cap Trays

Fabricated at DOWNINGTOWN IRON WORKS for Badger Manufacturing Company. Stress relieved...spot X-rayed...Code stamped. Field erected by Badger Manufacturing Company at UDEX Plant of Sinclair Refining Company, Marcus Hook, Pa. Send for Bulletin PF and learn more about Downingtown engineering experience and fabricating skill.

Downingtown Iron Works, Inc.

HEAT EXCHANGERS—STEEL AND ALLOY PLATE FABRICATION

1435 S. 66th St., Milwaukee 14 • 52 Vanderbilt Avenue, Room 2014, New York 17
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208 S. LaSalle St., Room 783, Chicago 4 • 560 Roosevelt Bldg., Los Angeles 17
151 Wallace Ave., Downingtown, Pa.
116 Riverside Circle, Marshfield, Mass.
4247 North Avenue, No. 21, Cincinnati 36, Ohio
57 E. Wentworth Ct., Room 116, Minneapolis 19, Minn.

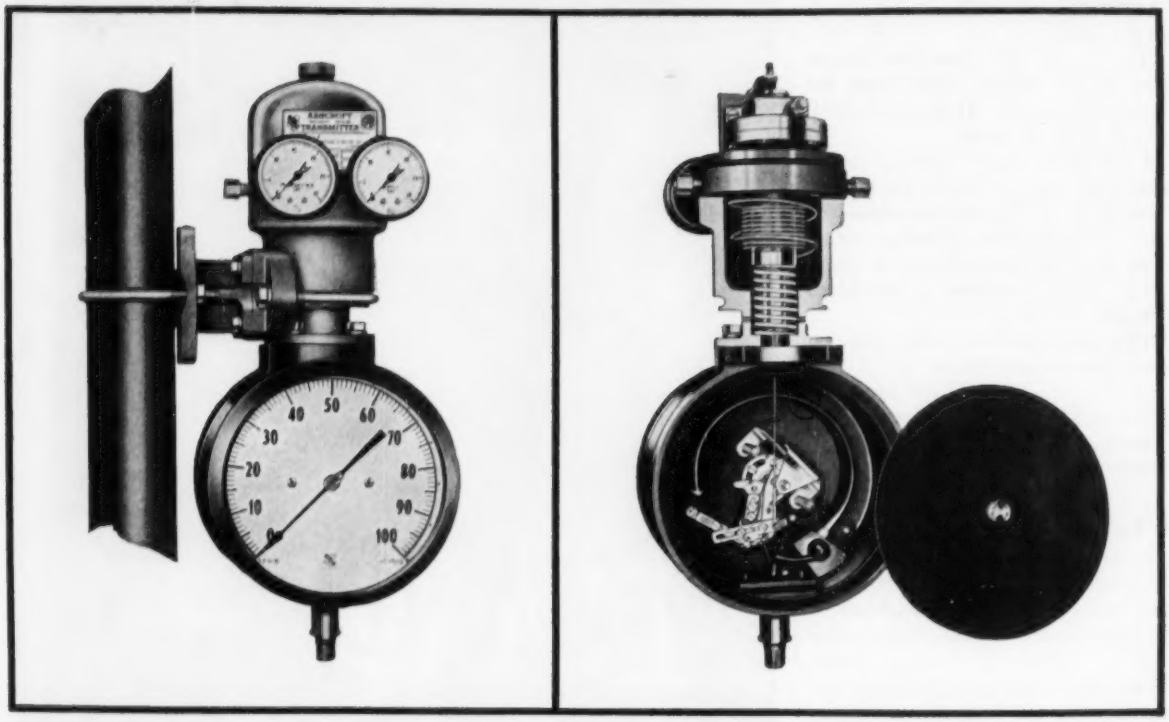
DOWNINGTON IRON WORKS Hackney

CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS

For more data on advertised products, use Readers' Service Cards, last page.

Designed to solve safety and service problems

...THE NEW ASHCROFT PNEUMATIC PRESSURE TRANSMITTER



This new Ashcroft Pneumatic Pressure Transmitter is particularly recommended to processing industries and power stations. It combines speed and accuracy with maximum protection and serviceability.

The new design features the 6" indicating Ashcroft Maxisafe Duragauge, long known for dependable performance. It has an integrally-cast solid metal wall between dial and pressure sensitive element so that the transmitter can measure pressures up to 100,000 psi with complete safety for personnel and equipment. If misapplication ruptures the Bourdon tube, the Teflon-coated back cover serves as a safety blowout relief.

Another outstanding design advantage is easy access to both gauge and transmitter sections. Simply remove the safety-relief back cover and both the gauge and transmitter can be calibrated. Yet a sealed housing makes the entire assembly weatherproof.

The transmitter operates on low-pressure air. No need for expensive high-pressure lines and fittings. Supply air pressure as low as 18-20 psi for 3 to 15 psi output provides especially advantageous operation where electrical wiring might be a hazard. Inflammable, poisonous or corrosive liquids or gases are confined close to their source, away from the central control point.

The Series 1250 Ashcroft Pneumatic Pressure Transmitter is available with pressure sensing elements in all standard pressure ranges and Bourdon tube materials. Installation of the transmitter is easy. Small diameter tubing may be used, and the pipe, stem, wall or flush mounts are interchangeable in the field. Get complete operational data and construction details. Write for Bulletin 340.

YOUR INDUSTRIAL SUPPLY DISTRIBUTOR has the broad knowledge and thorough experience essential to satisfy every requirement of your Ashcroft Pneumatic Pressure Transmitter application. You get fast, economical service from his local stocks.

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

ASHCROFT GAUGES

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Oklahoma.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

A Quick Look at the Industry THIS MONTH

Report on Suez . . . Military Petroleum Advisory Board is taking close look at amount of additional crude U. S. will have available for export should Nasser's folly shut off Europe's oil life line. Current estimate: 750,000 barrels a day over present domestic demand.

I.R.A.A. says independent refiners are prepared to give all-out assist should Suez crisis break. Group is completing plans to solve any oil problems which might arise in keeping Free Europe supplied with oil.

—•—

All Industry Outlook . . . Rising prices—decline in value of dollar—will be big issues in this election year. To offset inflation threat, government is taking steps to curb money borrowing. Industry will be hardest hit—may be forced to cut back expansion plans.

Despite possible capital shortage, plus slow recovery of construction from steel strike, 1956 will mark another record year for industry—nearly 6 percent better than '55.

—•—

Refining Outlook . . . Steel prices will level off about $10 a ton higher than pre-strike era. Result: Refinery construction costs will increase over 4 percent.

Oil product supply outlook: Bleak. Demand: Good. Although crude runs to stills were cut considerably in last half of August, crude and product stocks are still nearly 35 million barrels higher than in same '55 period. Over-supply will take its toll in coming months—if refined products aren't cut back sharply.

Looking at brighter side, total oil demand in Sept.-Oct. is expected to increase 4.6 percent (345,000 barrels a day) over same period in '55. Demand will average 8.6 million barrels a day. This compares with 9.4 million barrels a day new supply in August.

—•—

Two Versus Three . . . Majors boosting three or more grades of gasoline have had their day—now "two-grade" advocates have returned to the limelight. Socony-Mobil, Shell, Pure, Sinclair have recently announced they will stay with two grades. Their reasons are similar. Two grades—one for new high compression engine cars requiring higher octanes for knock-free performance, the other for cars requiring only regular gasoline—are all the U. S. motorist wants and needs.

Question: Are companies using third-grade gasoline pumps for super octanes now, planning to use that extra pump for gas turbine fuel in the future? Whatever the answer, Esso's sales of third pump 100-plus octane in 2500 "test" service stations are exceeding all expectations.

—•—

Fuel Injection On the Way? . . . Rumors have it that German-made auto—Goliath—may soon hit U. S. market—equipped with inexpensive fuel injection system. Will probably use regular gasoline. Cost: $1200.

A Quick Look at the Industry (continued)

Postings on Octane Race . . . As octane scramble gets hotter, the spotlight shifts to new refining processes.

Two Rexformers are now on stream. First was built by Aurora Gasoline Company, Detroit. Capacity: 5500 barrels a day. Second, Cosden Petroleum's $2.5 million Rexformer, Big Spring, Texas, was first to be constructed as integrated unit. Produces 4000 barrels of 100-plus octane product a day.

Process uses aromatic extraction and raffinate recycle to achieve super high octane product for gasoline blending.

Surplus in light materials resulting from recent upswing in reforming capacity may prove to be a further detriment to natural gasoline industry. However, growing trend toward alkylation should alleviate at least part of the problem. Some of light material supply may be alkylated into high-octane blending components.

-•-

Plug for Free Enterprise . . . Free of all government tethers, synthetic rubber industry is making phenomenal progress—will boost capacity 37 percent by '57 and will nearly equal total world natural rubber output in '58. Expected '58 production: 1.7 million tons (compared with 1.8 million tons of natural rubber)—40 percent over April '55, when government returned industry back to private producers.

-•-

Jet Fuel Demand Shoots Upward . . . From Oct. 1 to March 31, military will need about 35 million barrels of jet fuel. Breakdown: JP-3, 2.1 million barrels—JP-4, 32.9 million barrels—JP-5, 297,000 barrels.

Plans are to set aside at least 4 million barrels for small refiners.

Look for kerosine-type turbine fuel to win out over JP-4 for commercial planes. One engine manufacturer has set up these specifications and has received wide support from rest of industry. Among additives permitted: corrosion inhibitor and high temperature stability.

-•-

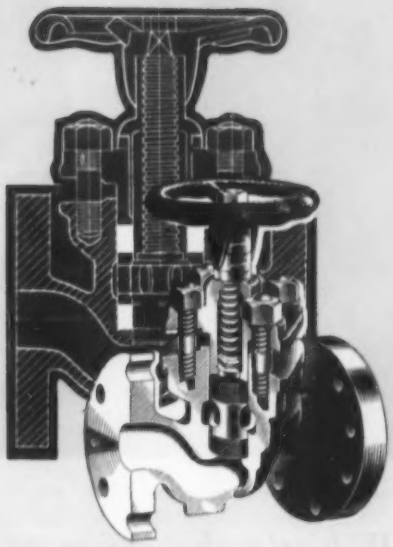
Rail Fuel Needs Are Changing . . . During first five months of '56, railroads used more gasoline and diesel oil—and less fuel oil—than in same '55 period. Amounts purchased: Fuel oil—4.8 million barrels, 700,000 barrels less than in '55; Gasoline—20 million gallons, up 1.7 million gallons; diesel: 1.5 billion gallons, up 100,000 gallons.

But conversion of truck, tractor and locomotive diesel power plants to two-fuel system is in foreseeable future. Advantage: By burning distillates when carrying idle or light loads—and residuals or blends under heavy loads—heavy vehicles will be able to take maximum advantage of fuel economies.

-•-

New Oil Fields Show Promise . . . Nothing spectacular in July's 98 oil fields, but several looked pretty good. Pick of the lot: Shamrock O&G's discovery in Ochiltree County, Texas Panhandle, testing 558 barrels of 36-gravity oil a day; White Eagle Oil and Freeport Sulphur's Ector County, West Texas, strike good for 516 barrels of 47-gravity; British American's 259-barrel, 42-gravity, find in Wood County, East Texas; Sinclair's offshore Louisiana discovery making 422 barrels of 32-gravity oil; and another in Louisiana, Pointe Coupee Parish, by Lang & Unger, gaged at 420 barrels of 41-gravity daily output.

Klingerise your plant



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The "K" Type Reflex Level Gage has the following outstanding advantages:—

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The Klinger Seatless Piston Valve operates on an entirely different principle from the usual type of seating valve. It consists basically of a finely ground piston, operated by the valve spindle and hand wheel, and moving through two or three non-metallic resilient valve rings, capable of resisting steam, oil and most fluids at high temperatures and pressures, and separated by a ported lantern bush. It is made in a great variety of sizes and designs, to suit all purposes, and has the following advantages:—

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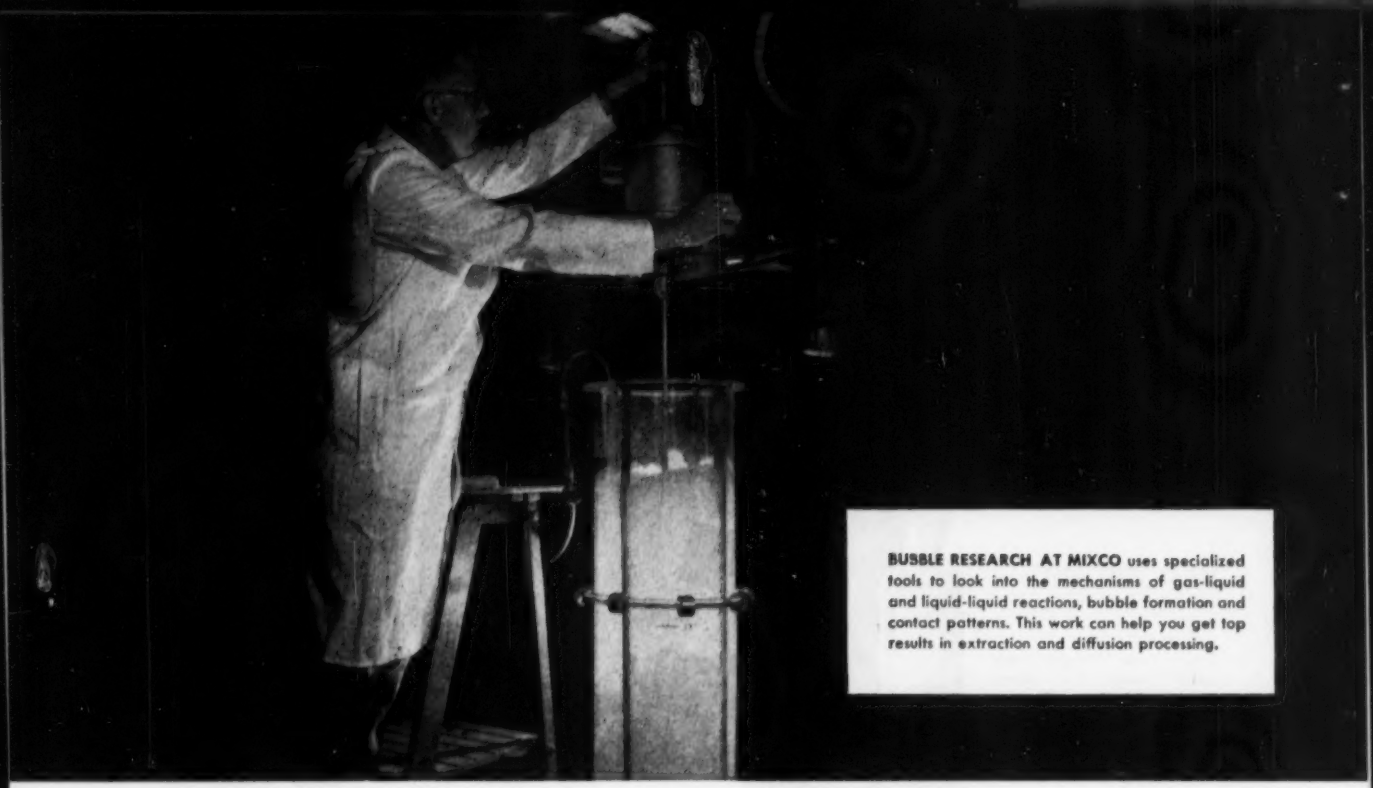

BUBBLE RESEARCH AT MIXCO uses specialized tools to look into the mechanisms of gas-liquid and liquid-liquid reactions, bubble formation and contact patterns. This work can help you get top results in extraction and diffusion processing.

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How to save research time

If your work involves gas-liquid contacting, you can save time by letting us figure out for you the most effective sparge ring diameter, and placement of holes, for a given horsepower level and gas flow combination.

On *any* fluid mixing operation, consider the time you'll save by making your pilot runs with calibrated mixing impellers that let you calculate power directly from simple speed measurements. (You can get these impellers from us; or have us do the calculating for you.)

And when you're ready to put the unit on stream, get the advantage of mixer selection from an almost unlimited range of power and speed combinations—with results accurately predicted and *unconditionally guaranteed.*

Doesn't this sound like the *practical* way to put fluid mixing to work for more profitable processing? Thousands of process engineers have found it so. For quick, competent help, phone your LIGHTNIN Mixer representative (listed in Refinery Catalog). Or write us direct.

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MIXCO fluid mixing specialists

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Smog—Too Big for Us to Handle?

For an industry that has solved many complex problems, how does smog stack up in complexity? Is it as difficult technically as changing gasoline quality from a fuel for 7:1 compression ratio engines to a fuel for 10:1 engines? Will it cost as much as we've spent to iron out production of petroleum products so that there's plenty of fuel oil available in the winter and ample gasoline in the summer? Is the community relations effort more difficult than providing continuous employment so that SUC is not needed in union contracts?

No, we'd say that the problem measured up to these achievements of the refining industry is small. Smog is a problem that our industry has already tackled and we see no reason why a satisfactory solution will not be forthcoming.

Refining has received a big part of the blame for smog; and even though we don't concede it's our fault, we're making a big effort to solve this community problem. It will cost money and the return in dollar profit is not in evidence. But with our resourcefulness, the refining industry is naturally looked to by the public to solve the problem. Our approach is to maintain the respect and admiration which we have built up in past years of achievement.

Though the exact cause of smog has not been established yet, these accomplishments can already be pinpointed:

• Western Oil and Gas Assn. began in 1951 to finance research into the cause of trouble in Los Angeles. The project was assigned to Stanford Research Institute.

• API established a Smokes and Fumes Committee in 1952 which received an initial budget of $250,000 to find the answers to air-pollution problems. This committee established projects at a half dozen institutions and universities who have made the following discoveries. Stanford University delved into how substances are formed in the atmosphere and learned that sunlight may be responsible for creating new ones which otherwise would not exist. Chicago's Armour Research Foundation analyzed smokestack gases and found that none gave off enough hydrocarbons to cause smog. The Kettering Laboratory at the University of Cincinnati scotched the unfounded claim that it was the refiner's sulfur dioxide effluents which caused smog by showing that SO_2 is scarcer in Los Angeles than in cities with far less pollution. Further, Dr. H. F. Johnston at the University of Illinois discovered that SO_2 in the atmosphere is not converted to sulfuric acid to any considerable extent.

• Franklin Institute has accomplished one of the greatest goals so far—to construct an apparatus which could identify those finely dispersed pollutants which irritate the human eye, nose and throat. At Montreal, the Franklin team reported it had constructed an infrared cell which can detect pollutants in quantities as low as five parts in one hundred million parts of air. In addition, this team discovered just such an elusive substance—one which exists briefly during the formation of smog. What it is and how it contributes to the problem is something that will still have to be learned.

• In Los Angeles itself, beleagured oil companies have spent $3,000,000 in research and more than $25,000,000 for special air pollution control equipment.

• In Houston (a city which depends heavily on the refining industry) the forthright attack has been to get at smog before it's really a problem. Sponsored by the Chamber of Commerce, Southwest Research Institute has been hired to find the extent of smog already in Houston and to compare it with other communities. Further, they will study how the public can be informed of the answers to smog problems. Though the refining industry cannot claim full credit for this "preventive maintenance," the five oil members on the Chamber's Board of Directors brought influence in the decision to start this project. Also, one of three member's of the Sponsor's Committee is Lowber D. Snow, formerly staff advisor in the Houston Division Engineering Department of the Gulf Oil Corporation.

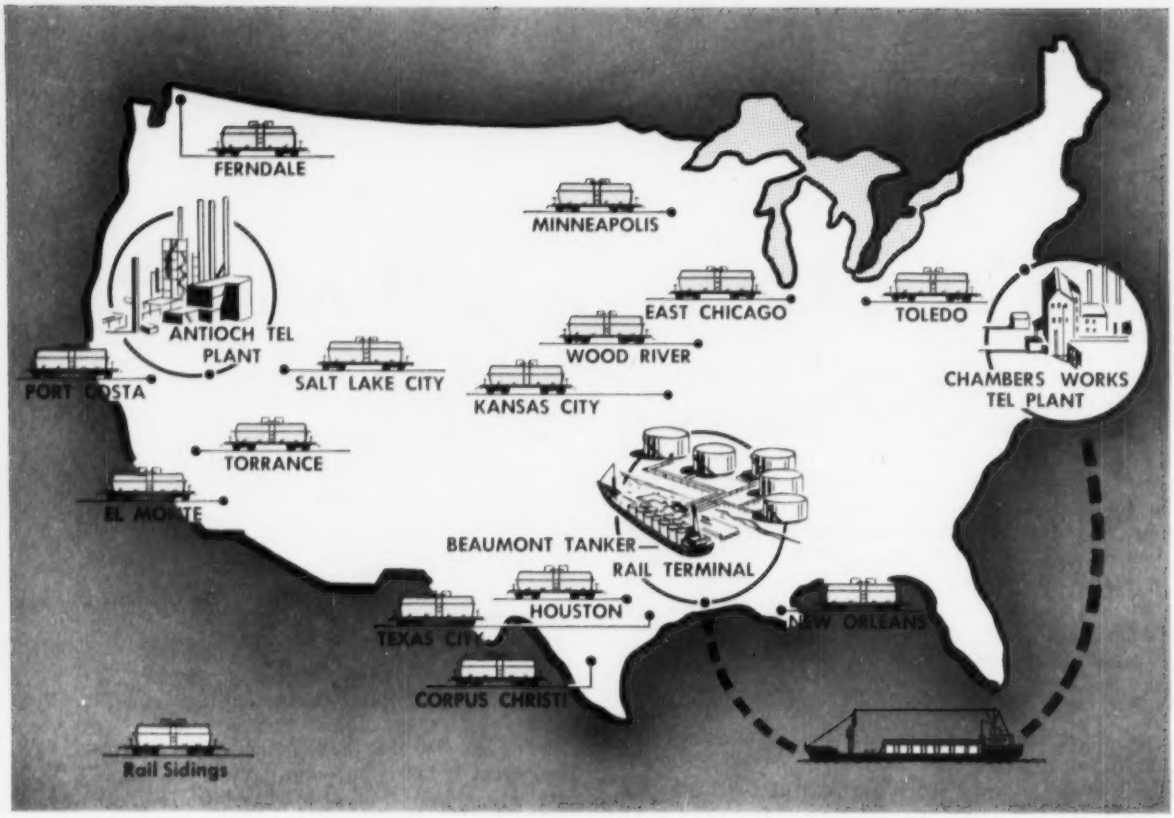
We conclude that smog is a problem that refining can eventually solve.

Lettuce, Suits and Hats

LAST YEAR, Americans squeezed millions of heads of lettuce—compared fabrics in countless thousands of suits—and tried on as many hats before they found the *quality* they wanted for the price they were willing to pay.

Yet, in 1955, those same Americans spent $12 billion on one product without a thought of examining it! *That product was gasoline.* The six out of ten families who own cars *knew they could depend on its quality.*

If U. S. consumers think that much of the oil industry's products, then there is no reason on this earth



Du Pont's expanded production and delivery program moves ahead

West Coast TEL plant to go on stream by year's end . . . special tanker will transport TEL by sea for first time . . . new Du Pont storage and delivery terminal nears completion at Beaumont, Texas.

The Du Pont Petroleum Chemicals 1956 expansion program is nearing completion. It will meet increasing requirements, insuring ample TEL supplies and fast delivery service to refiners in all parts of the country.

On the West Coast

Du Pont's new TEL plant at Antioch, California, the most modern in the world, is now well over 50% complete. It is expected to go on stream by the end of 1956. Readily accessible to water, truck, and rail transportation, this means larger supplies and faster deliveries for West Coast refineries.

Gulf Coast

A tanker-supplied storage and delivery terminal is nearing completion at Beaumont, Texas. TEL will be transported from Du Pont's Chambers Works at Carney's Point, N. J., to Beaumont in a specially built tanker. This will be the first time TEL has ever been shipped in bulk by sea.

Upon inauguration of this service, Gulf Coast and mid-continent refineries will have additional assurance of ample TEL supplies.

Nationally

Refiners all over the country can benefit by Du Pont's increased TEL supply facilities including the many existing storage points throughout the nation.

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why they can't think as well of the industry itself. And they *will* think as well of the industry, *if* those whose livelihoods depend on its growth will get out and support it.

The oil industry's "good will ambassador" potential goes far beyond its two million employes. There are millions of shareholders who have just as much at stake—as do the thousands of service station dealers.

The time is approaching when every employe—every shareholder—every service station dealer can do his part in winning friends for the industry. *That time is Oil Progress Week October 14-20.*

The Oil Industry Information Committee once again has prepared a potent arsenal of true facts about our great industry. The tools to disseminate those facts will be available through movies, speeches, printed matter, placards, billboards, editorials, feature articles, decals and so on, ad infinitum.

The equipment to make Oil Progress Week succeed will be in plentiful supply at every area O.I.I.C. office—the *extent* to which it succeeds will be in direct proportion to the number of volunteers willing to work.

The steps toward making Oil Progress Week a tremendous success are simple:

(1) Make up *your own mind* to help your industry by participating in Oil Progress Week.
(2) Ask your friends to volunteer with you.
(3) Contact your nearest OIIC area office and ask what you and your friends can do to help.

By following these three simple steps you can help the oil industry take a long step toward being as highly thought of as the fine products it manufactures. *Do your part.*

A Step Away From Freedom?

WHEN THE U. S. Supreme Court handed down its recent decision in the case of *Railway Employes' Department, AFL vs. Hanson, et al,* this nation took a step away from freedom.

In that ruling the Court held invalid, insofar as railway labor is concerned, an amendment to Nebraska's constitution which provides that no one shall be required to join or refrain from joining a labor organization as a condition of employment. The court's decision was based on a clause in the National Railway Labor Act which permits union shop contracts notwithstanding the laws of any individual states.

The court did not pass on the broader question of whether compulsory unionism under union shop agreements violates the basic rights and freedoms of individuals as guaranteed in the Constitution of the United States.

The fact that the Supreme Court decision pertains only to railroad employes is of small significance in light of its potential effect on all U. S. labor. This is just one example of the growing political influence of unionism.

Another example is the repeal of Louisiana's right to work law in June—as a direct result of the political power and pressure of organized labor. To quote an AFL-CIO spokesman, "The action in Louisiana, a southern state, demonstrates the growing political effectiveness of the labor movement."

This political power, increasing every day, is being directed against the 17 states that still have right to work laws—and is being directed with even more intensity against Section 14(b) of the Taft-Hartley Act which saves these laws from being killed by the Supreme Court.

If organized labor succeeds in its objective the constitutional rights and freedoms of *all* employes in unionized industries—oil included—will be discriminated against in favor of the power and prestige of their union overlords. No longer will union leaders and officials need to serve their members; they will rule them automatically, even as they do now in the 31 states which afford no legal protection against compulsory unionism.

It is sad commentary that such a situation exists in a nation dedicated to the preservation of individual rights and liberties.

Only an aroused public, awakened and informed by a free press, can correct it.

Gasoline Stocks Need Trimming

LITTLE HEADWAY is being made against the industry's problem of not being able to reduce its inventories of gasoline fast enough. Although motor fuel consumption rates are currently at peak levels, high production rates are preventing these stocks from being drawn down as rapidly as they should be for this time of the gasoline demand season.

Refiners have persisted in taking large gasoline cuts from the record volumes of crude processed in their plants. Consequently, the huge volumes of motor fuel manufactured have prevented gasoline stocks from being reduced at normal rates.

On the other hand, the distillate fuel oils have not been getting the attention they might have had. Stocks of these oils have trailed last year's volumes for several months, and their rate of accumulation could have been stepped up very comfortably. Only in recent weeks have distillate oil stocks pushed higher than last year's inventories.

Yet gasoline stocks have consistently been held to levels more than 20 million barrels above last year's high volumes. With the end of the heavy gasoline season approaching, there is little time remaining to work off excessive supplies. Only immediate and substantial reduction in gasoline output can prevent these stocks from becoming burdensome during the off-season buildup period.

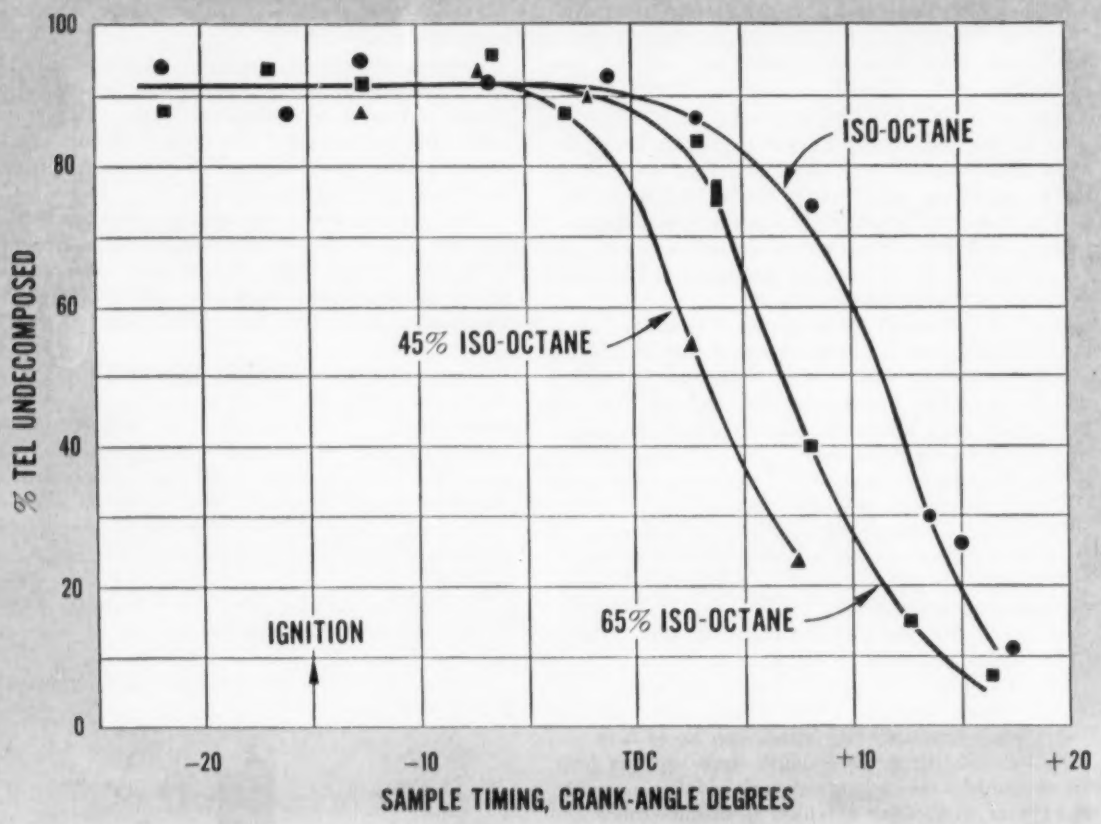

Fig. 1. TEL decomposition in fired engine. Fuels: mixtures of iso-octane and n-heptane containing 6 ml TEL per gallon.

New research on antiknock action

by ELLIS B. RIFKIN
Ethyl Corporation, Detroit, Mich.

Although tetraethyllead is widely used as an antiknock agent, some fundamentals of its action are still not completely understood. Since a full understanding of the mechanism of its action could presumably lead to increased effectiveness of utilization—the Ethyl Corporation conducts a continuing basic research program on antiknocks.

Many theories concerning the mechanism by which tetraethyllead acts as an antiknock in the internal combustion engine involve either the process by which tetraethyllead decomposes or the products resulting from such decomposition.

This report describes the studies of variables affecting the decomposition of tetraethyllead both in fired engines and in motored engines.

In a first series of experiments, a spark-ignited, fixed-compression ratio, L-head engine was employed. This engine was equipped with a sampling valve of special design which permits repetitive extraction of small samples from the end-gas region of the combustion chamber.

Mixtures of iso-octane and normal heptane were used as fuels, and end-gas samples were taken at 5° intervals from 25° before top center to 20° after top center. The results of these studies are indicated in Figure 1 which shows:

1. That essentially all the tetraethyllead is decomposed before the mixture is consumed by the flame front.

2. That the rate of tetraethyllead decomposition is markedly affected by fuel composition.

In order to resolve this effect of fuel composition more completely, it was decided to conduct a second series of experiments—this time in a motored engine, to permit measurement of temperatures. A single-cylinder engine was again used, but in this series of experiments, the engine was of the variable-compression ratio type to permit variation of temperature and pressure of the fuel-air mixture over as wide a range as possible.

Mixtures of iso-octane and normal heptane as well as di-isobutylene were the fuels tested. Figure 2 illustrates the effect of fuel composition on tet-

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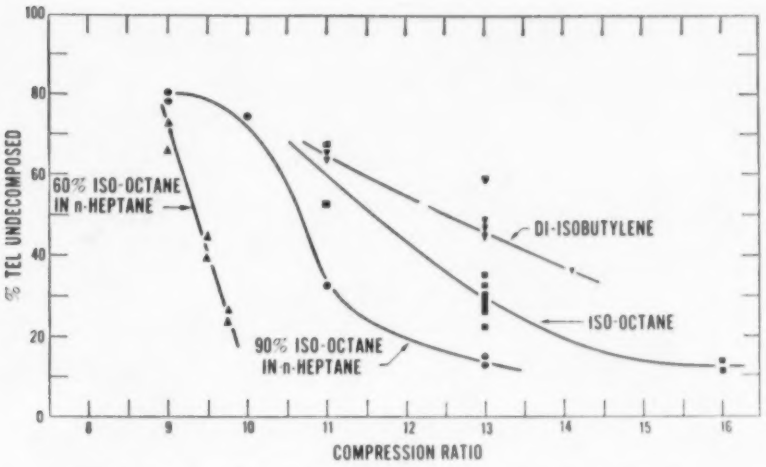


Fig. 2. Effect of fuel on TEL decomposition in a motored engine.

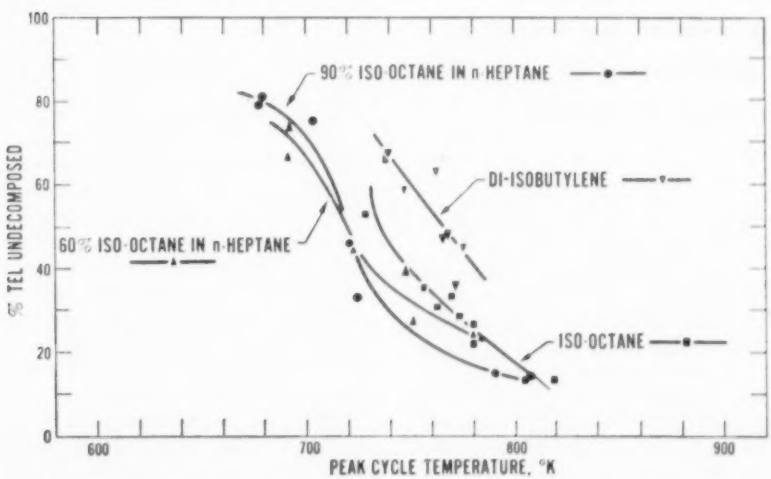
raethyllead decomposition in the motored engine—somewhat comparable data to that shown in Figure 1 for the fired-engine studies.

Again, an apparent correlation was obtained between fuel composition and rate of tetraethyllead decomposition—with the more rapid rates being associated with fuels of higher octane number.

To gain still greater insight into this relationship, technicians calculated peak cycle temperatures and the tetraethyllead decomposition data were examined against this variable. The results of this work are shown in Figure 3. It can be seen immediately that most of the variation due to fuel composition has been eliminated. This leads to the conclusion that temperature may be the one basic variable governing the decomposition of tetraethyllead—and that fuel composition has only an indirect influence so far as it affects the peak temperature of the charge in the cylinder. A mathematical analysis taking into account the variation in temperature of the charge throughout the cycle and comparison of those data with tetraethyllead decomposition data confirm this conclusion.

This account of one typical research project in the Ethyl Laboratories is designed to give you in the petroleum industry a glimpse into the vast body of continuing research being carried out to guarantee the maximum effectiveness of "Ethyl" Antiknock Compound.

Fig. 3. TEL decomposition in four fuels related to peak cycle temperature.



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Searching for answers to these "basic" problems has led us to develop many new instruments and new techniques. The information which we have developed from our research efforts is being constantly circulated throughout both the automotive and petroleum industries to help the different companies with their research.

If you desire any information concerning fuel-engine problems, just contact your Ethyl Laboratory Technical Representative.

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FIGURE 1—Phillips Petroleum Company's fractionator facilities at Phillips, Texas, are the largest in the world for separating natural-gas liquids into gasoline, butane, propane and other materials for fuels and chemicals.

Postwar construction . . .

Phillips Gears Operations For Wide Diversification

A decade of Phillips expansion has increased its refining capacity almost three-fold, has brought its petrochemical operations into prominence in new fields, and has boosted its output of natural gas liquids.

DIVERSIFICATION has been one of the keys to a postwar expansion which lifted Phillips Petroleum Company from the class of a small independent refiner into the ranks of the majors.

When World War II ended, this company was operating three refineries with a combined daily charge capacity of 81,000 barrels; it was manufacturing carbon black and butadiene, and was recognized everywhere as a pioneer in the use of natural-gas liquids.

In the decade since, it has doubled the number of its refineries in operation, and its total charge capacity has been increased almost three-fold.

Its petrochemical operations have been expanded to include the whole field of rubber chemicals, and facilities have been added for the production of fertilizers, plastics and other chemicals.

In natural-gas liquids, it now stands as the world's largest producer.

REFINING

The company's three refineries—at Phillips, Texas; Kansas City, Kansas, and Okmulgee, Okla.—processed 29,400,000 barrels of crude oil in 1946. This was a far cry from the 83,500,000 barrels it processed in 1955.

Today, Phillips is operating six domestic refineries with a combined daily charge capacity of 240,000. Here is the location and capacity of those plants:

Plant	Crude Cap. Bbls. Daily
Phillips, Texas	71,000
Sweeny, Texas	83,000
Kansas City, Kansas	54,000
Okmulgee, Okla.	17,000
Woods Cross, Utah	12,500
Great Falls, Mont.	2,500

Much of this increased capacity came through purchases completed in 1947. That year, the Sweeny refinery was acquired from the government, and a merger with Wasatch Oil Company gave Phillips refineries with a combined capacity of 15,450 barrels a day at Woods Cross, near Salt Lake City, at Great Falls, and at Pocatello, Idaho, and Spokane, Wash.

The latter two of these later were shut down. The Idaho refinery was closed in 1952 because the area it had served could be supplied more eco-

nomically from the modernized Woods Cross refinery. And the small refinery at Spokane was shut down the following year.

Within a year from the time of its purchase the refinery at Sweeny was processing 35,000 barrels a day. And in 1949, it was enlarged to operate at a rate of 45,000 barrels a day.

A new crude still and rehabilitation of the alkylation unit increased capacity of the Sweeny refinery by 22,000 barrels a day in 1951, and additional improvements have since pushed its capacity to about 83,000 barrels a day.

Catalytic Cracking—Today, Phillips is operating three fluid catalytic-cracking units with a combined charge capacity of 110,000 barrels a day, and two Thermofor catalytic-cracking units with a combined charge capacity of 20,000 barrels a day.

Completed at the Kansas City refinery in 1949 were a catalytic-polymerization unit, a heavy-oil vacuum-distillation unit and the company's first fluid catalytic cracker—a unit now processing 40,000 barrels a day. This increased that refinery's crude capacity to its present rate of 54,000 barrels a day.

New Thermofor catalytic-cracking units were completed and placed in operation at Phillips refineries at Okmulgee and Woods Cross in 1952. Each has a daily capacity of 10,000 barrels.

In 1951, a new fluid catalytic-cracking unit was placed on stream at the Phillips refinery. This, together with other improvements, resulted in an increase in the capacity of that refinery from about 56,000 to 71,000 barrels a day.

Catalytic Reforming—Since the war, Phillips has installed three new catalytic reforming units, each with a daily capacity of 16,000 barrels. The first of these was put into operation at Sweeny in 1954. A similar unit went on stream at the Phillips refinery the following year. And more recently another reformer has been installed, this time at Kansas City.

Other Additions—In addition to this modern cracking and reforming capacity, Phillips installed a new lubricating-oil plant at its Kansas City refinery. Built in 1948, this plant has the capacity to turn out 84,000 gallons a day of finished lube oil, and

FIGURE 2—Catalytic-cracking and crude units at Phillips Petroleum Company's Sweeny, Texas, refinery.

construction is underway to increase that capacity to 100,000 gallons.

When the Kansas City plant was completed in 1948, Phillips shut down the lube-oil facilities of its Okmulgee refinery. The main portion of the refinery continued in operation however, and a new catalytic-polymerization unit was installed the following year.

An increase in capacity for producing high-grade alkylate resulted from revisions to units completed in 1953 at the Sweeny and Phillips refineries. These two hydrofluoric-acid alkylation units now have a combined capacity of 13,600 barrels a day.

At Phillips, a 20,000-barrel-a-day solvent-extraction unit for the preparation of cracking stocks and special oils for the manufacture of carbon black was placed in operation in 1951.

PETROCHEMICALS

Phillips Chemical Company, a wholly-owned subsidiary, was organized after World War II to consolidate the company's growing petrochemical program.

During the war, Phillips had developed a process for making carbon black from oil, and in 1947 a four-fold expansion of its carbon-black facilities at Borger was begun.

The following year, the 70,000-ton-a-year Cactus ammonia plant at Etter, Texas, was leased from the government.

Concurrent with the leasing of the Cactus plant, Phillips purchased from the government a former shipyard site on the Houston Ship Channel (now the Adams Terminal) to provide a site for future ammonia, fertilizer and other chemical-manufacturing operations.

In 1950, the company also took over operation of the Plains copolymer plant at Borger.

In its program of post war expansion into the petrochemical field, Phillips has:

1. More than doubled production of the Cactus ammonia plant.
2. Installed and later expanded a government-owned nitric-acid plant at Cactus.
3. Installed an ammonium-nitrate plant and a nitrogen-solutions plant adjacent to the Cactus plant.
4. Installed and later expanded ammonium-sulfate plant at Adams Terminal.
5. Installed a triple superphosphate plant at Adams Terminal.
6. Installed an ammonia plant at Adams Terminal.
7. Acquired the Borger butadiene and copolymer plants from the government.
8. Built two sour gas sulfur-recovery plants.
9. Built a methylvinylpyridine plant at Adams Terminal.
10. Built a paraxylene plant.
11. Started construction of an ethylene plant at Sweeny, Texas, and a polyethylene plant at Adams Terminal.
12. Arranged to operate a new ammonia plant in the Pacific Northwest.

In addition to these activities carried on by Phillips Chemical Company, the parent company is engaged

Phillips' Construction . . .

in significant petrochemical operations. These include cyclohexane, solvents and high-purity hydrocarbons.

Rubber Chemicals

Carbon Black—After years of research, Phillips perfected in 1942 a high-quality, high-yield carbon black made by a furnace process using oil as a feedstock. Overall recovery efficiency is as much as ten times as great in the Phillips furnace process as in the channel process.

The first commercial plant to produce carbon black from oil was placed in operation by Phillips in 1943 at Borger. This plant since has been expanded and now is operating with an annual capacity of 290 million pounds.

Butadiene—A process developed by Phillips before the war called for the use of normal butane as a feedstock for synthesizing butadiene. As the result of this development, the company was prepared for its first major step into chemical diversification when it entered the wartime synthetic-rubber program. It helped pioneer the design and construction of butadiene plants and developed the furfural extractive distillation method of butylene and butadiene purification now used in a number of plants.

The butadiene plant at Borger, which Phillips designed and constructed, was placed in operation in 1943. Phillips continued to operate this plant for the government until 1955 when it was purchased under the synthetic-rubber disposal.

When Phillips bought the plant it had an annual capacity of 74,000 short tons. Capacity later was increased, and further expansion is underway.

Synthetic-Rubber—In 1950, Phillips Chemical assumed operation of the government-owned copolymer synthetic-rubber plant at Borger, and it was purchased from the government in 1955. At the time of its purchase, the plant had a yearly capacity of 57,600 long tons, and authorized expansions will increase this capacity to 108,000 tons.

To further develop synthetic-rubbers, Phillips is building a new rubber plant adjacent to the copolymer plant at Borger. This plant replaces an existing facility and will incorporate the latest advances in development and testing of new polymers.

Fertilizers

Anhydrous Ammonia—In 1948, Phillips Chemical leased the government's Cactus Ordnance Works, not far from Amarillo, Texas, and began producing anhydrous ammonia from natural gas. An improvement and expansion program was started, and today the plant is turning out ammonia at the rate of 500 tons a day.

In 1951, construction was started on Phillips' second ammonia plant, a 525-ton-per-day facility at Adams Terminal. And in 1955, Phillips and Pacific Northwest Pipeline Corporation organized Phillips Pacific Chemical Company to operate a 200-ton-per-day ammonia plant in the Pacific Northwest. This plant is due to be completed this fall.

Sulfur—In West Texas, Phillips Chemical has constructed two sulfur plants which use hydrogen-sulfide gas from adjacent natural gasoline plants as a feedstock. These plants, completed at Goldsmith and Crane in 1952, have a combined capacity of approximately 200 long tons of sulfur per day. After the product is converted to sulfuric acid, it is used in the production of ammonium sulfate and triple superphosphate at Adams Terminal.

Ammonium Sulfate—In 1948, Phillips started construction of an ammonium-sulfate plant with a yearly capacity of 200,000 tons at Adams Terminal. This plant was put in operation in 1949, and has been expanded to produce 365,000 tons a year.

Ammonium Nitrate—Concurrently

See PHILLIPS', page 424

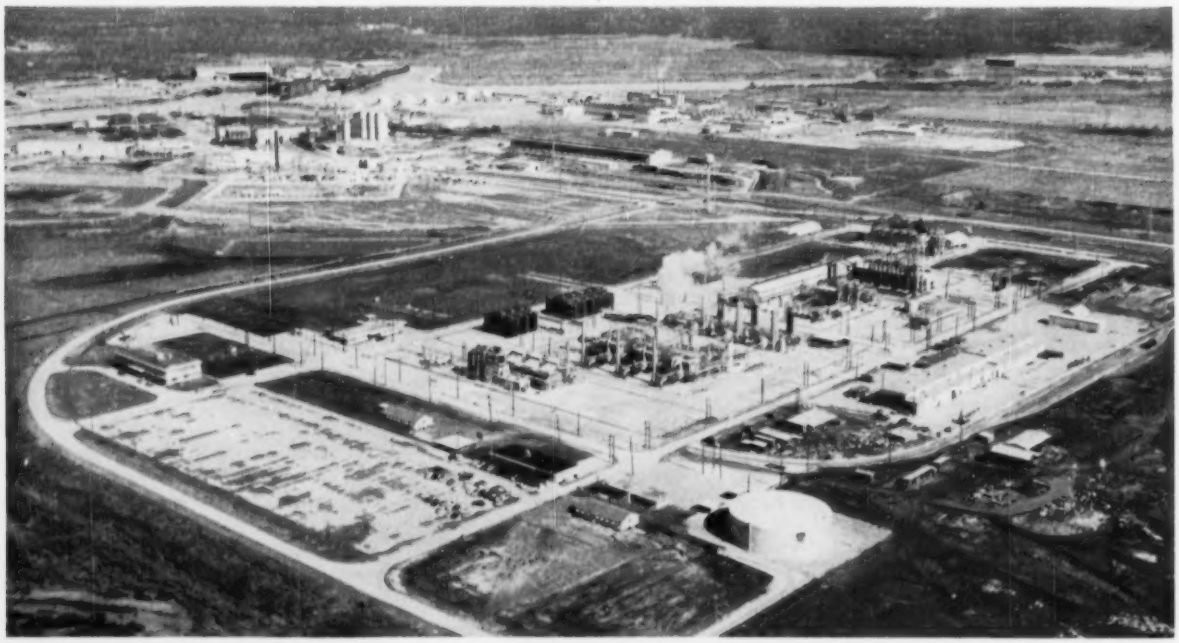

FIGURE 3—Adams Terminal ammonia plant is one of several fertilizer plants operated by Phillips Chemical Company. This plant near Houston turns out triple superphosphate, ammonium sulfate and methylvinylpyridine, and will produce plastics.

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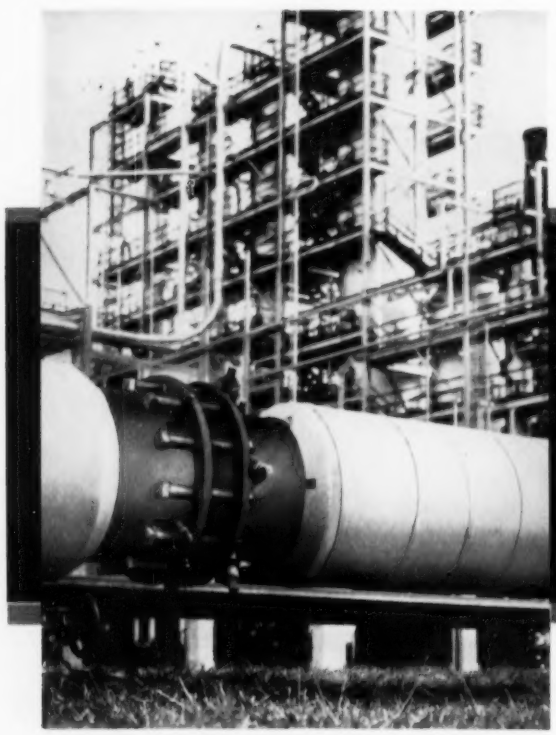

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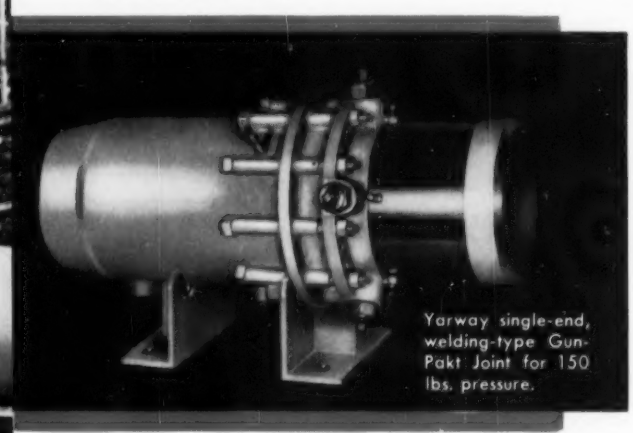

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YARWAY GUN-PAKT EXPANSION JOINTS

THEY HELPED PLAN THIS ISSUE. A conference was held to establish the limits and type of material to be included in the 1956 Process Handbook. Attending the conference were these industrial experts shown above, left to right: V. A. Kalichevsky, Magnolia Petroleum Company, Beaumont, Texas; O. D. Edwards, Phillips Petroleum Company, Bartlesville, Oklahoma; W. F. Sims, Blaw-Knox Company, Tulsa, Oklahoma; H. L. Hoffman, REFINER staff; T. W. Warren, Ethyl Corporation, Detroit, Michigan; and R. F. Stahl, American Oil Company, Texas City, Texas*

PROCESS ISSUE—1956

TO KEEP ABREAST of processing techniques is to keep abreast of the petroleum industry. That's why we are again devoting the September issue to processes.

Since our last edition was published in September, 1954, many new processes have been introduced to the industry. A few of the more recent ones are: Iso-Plus, Rexforming, Powerforming, Penex, Pentafining, and the two-stage fluid catalytic cracking process.

All of these processes are described in this new edition of the Handbook. A few of the descriptions concern processes for which there are no commercial installations yet, but we included them for your information.

More recent data are reported also on some of the older processes which have appeared previously. These processes are still the backbone of the industry; therefore, their inclusion is required to make the Handbook complete. This edition, then, is an up-to-date summary of the industry—a useful addition to your personal reference library.

The processes are grouped in much the same manner as in past editions with the exception that some of the groups are subdivided into more specific types. For instance, the section on "Gas Conversion" in previous editions has given way to "Alkylation," "Polymerization," and "Isomerization." A glance at the indexes on the following pages will give you an idea of the scope of these descriptions and other categories into which this useful material is placed.

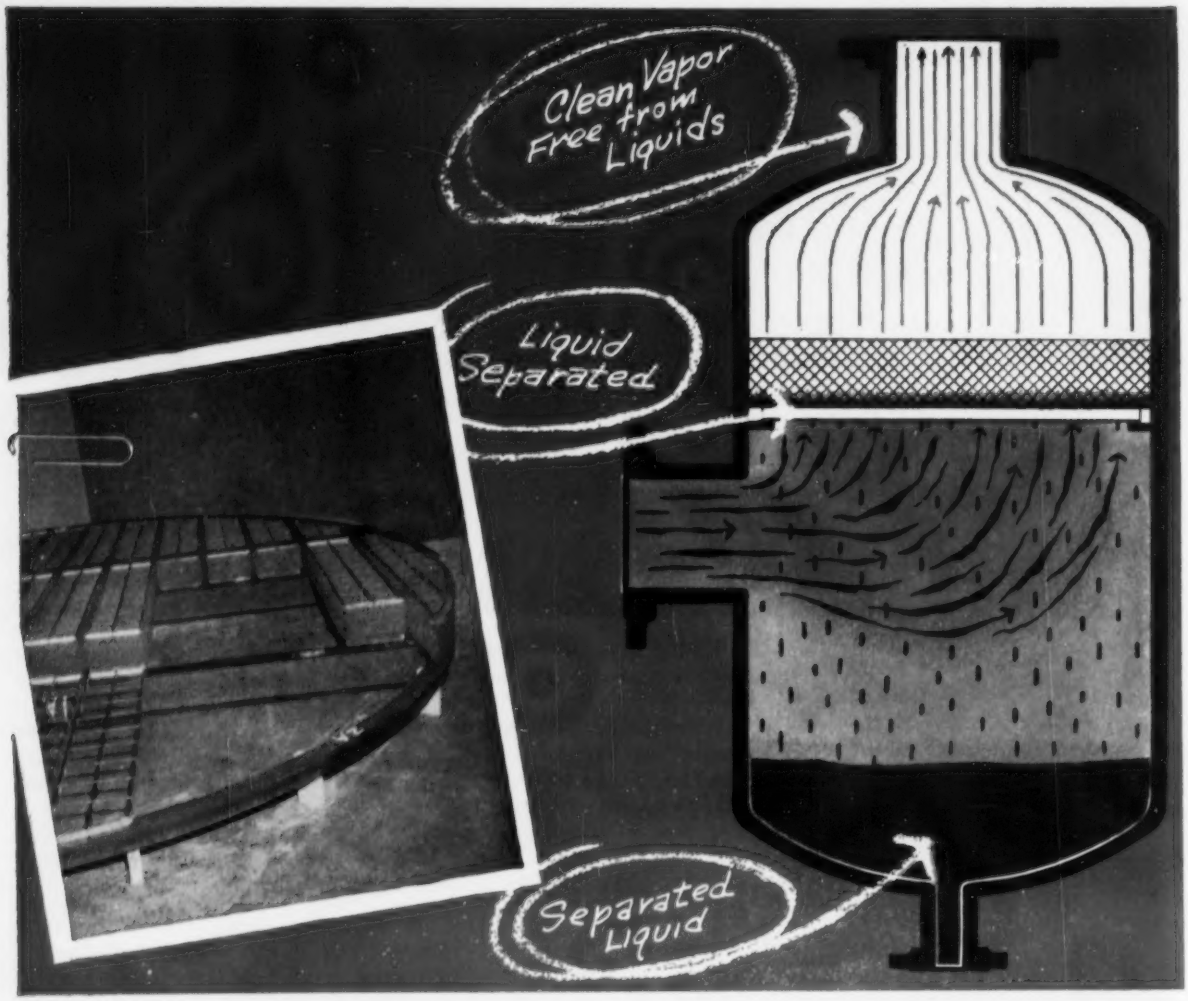
In any handbook of this type, space is too limited for the contributor to give a complete description of his process. Therefore, we are including, where available, a literature reference. This should prove useful to the reader who wants more detailed information on a given process.

And don't overlook the special report which follows the processing section. It is a summary of treating methods. Of course, the main emphasis is on hydrodesulfurization, but chemical and additive methods are included for comparison.

Harold L. Hoffman

* The attendance by executives, engineers, superintendents or other employes of oil companies at these conferences does not constitute an endorsement of the REFINER over any other publication. The fact that men of outstanding ability are allowed to attend these planning conferences shows the interest which companies have in sound editorial content for the benefit of the industry.

PETROLEUM REFINER
Process Handbook



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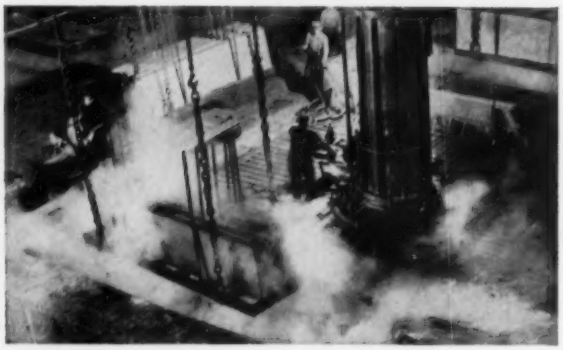

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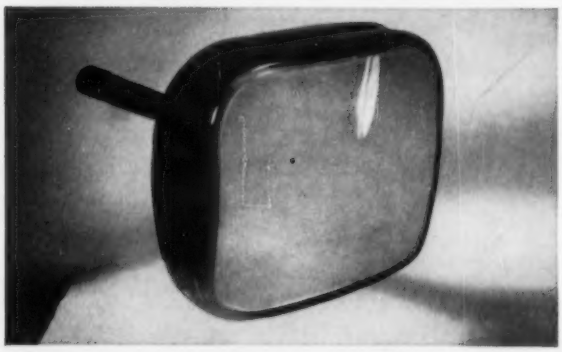

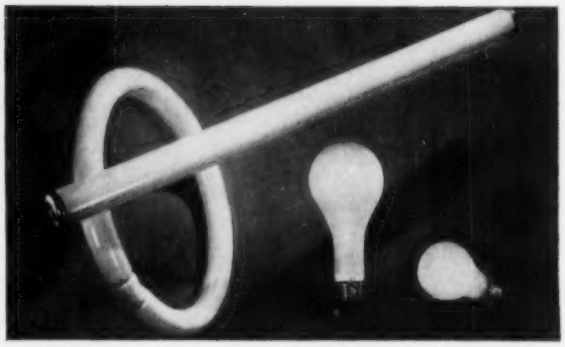

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CONDENSER TUBE CLINIC

Edited by **ARTHUR W. TRACY**, Metallurgical Engineer,
The American Brass Company, Waterbury, Connecticut

Stresses and their Effects can be Minimized

STRESS-CORROSION CRACKING—The stress-corrosion cracking of copper alloys requires the simultaneous action of moisture, air, ammonia, and stress. Stresses may be residual or applied. All Anaconda condenser tubes are processed so as to minimize residual tensile stresses which may be formed during fabrication. Applied stresses from installing tubes in heat exchangers, nonuniform thermal expansion in tube bundles, or misalignment of condensers with other equipment occasionally cause stress-corrosion cracking.

Admiralty metal and aluminum brass tubes, although known to be susceptible to stress-corrosion cracking, seldom crack in condensers. Although ammonia is often present, either by chance or design, in vapors entering condensers, the amount of air (oxygen) is usually so small that the corrosive action of the ammonia is limited. It is obvious that noncondensable gases should be vented from condensers, not only to increase thermal efficiency, but to minimize corrosion.

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FATIGUE CRACKING—Vibrations from moving parts of equipment or from pressure pulsations can induce stresses in condenser tubes high enough to exceed the endurance limit and cause a fatigue-crack failure. Vibration of a tube may even disturb water flow enough to cause impingement pitting at the point of greatest amplitude of vibration and the resulting pits can act as stress raisers. Pulsations can often be dampened by placing baffles or grids in the path of high-velocity vapors. Vibration of tubes can also be dampened by placing wooden slats between rows of tubes. Cupro Nickel, 30%-702 Tubes are more resistant to fatigue cracking than admiralty and aluminum brass.

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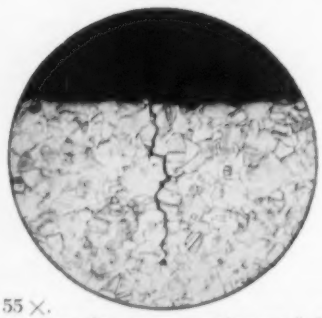
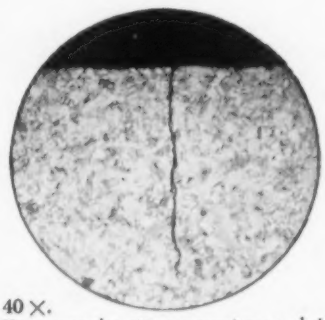
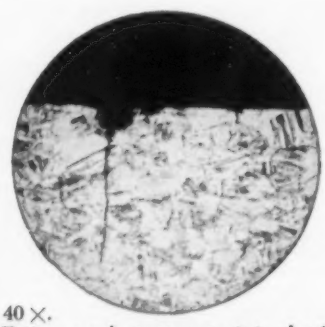


55 ×.
Intergranular stress-corrosion crack in 70/30 brass tube from oil refinery heat exchanger. Longitudinal section.



40 ×.
Transgranular stress-corrosion crack in admiralty metal tube from oil refinery heat exchanger. Longitudinal section.



40 ×.
Fatigue crack starting at pit in aluminum brass tube from power plant condenser. Longitudinal section.

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Nominal Compositions of Some Anaconda Condenser Tube Alloys

	Arsenical Admiralty -439	Ambraloy -927 (Aluminum Brass)	Cupro Nickel, 10%-755	Cupro Nickel, 30%-702
Copper, %	71	77	88.35	68.90
Nickel, %	..	..	10	30
Zinc, %	27.96	20.96	..	..
Aluminum, %	..	2	..	..
Tin, %	1	..	..	..
Arsenic, %	0.04	0.04	..	..
Manganese, %	..	..	0.40	0.60
Iron, %	..	..	1.25	0.50

For more data on advertised products, use Readers' Service Cards, last page.

Reforming

PETROLEUM REFINER Process Handbook

REFORMING is primarily a hydrogenation process. It converts low-octane naphthas and gasolines into high-octane components for motor fuel blending.

The term reforming also has been applied to the cracking of hydrocarbons, alone or in the presence of steam. Nevertheless, its more modern usage within refineries is confined to the principle of rearranging hydrocarbons in the presence of hydrogen to achieve octane improvement. Both thermal and catalytic processes are used, but by far the greater interest now is in catalytic reforming.

The present capacity for catalytic reforming in the U. S. is 1,200,000 barrels per day. This is a tremendous quantity for a process whose purpose is not to increase the out-put of gasoline products but only to upgrade their quality. This capacity is equivalent to about 13 percent of our total crude running capacity, or in other words, enough to furnish as much as 30 percent of the national demand for gasoline—both regular and premium.

Many additional reformers are in construction stage. It is expected that the new ones which go on stream between now and the end of the year will shove our reforming capacity up to 1,280,000 barrels per day. This is not only a large volume for a quality improving process, but it represents a fantastic rate of growth.

A review of reforming shows that thermal reforming for octane improvement was not practiced until after 1930. It was 1940 (see box below) before the U. S. industry came on stream with its first catalytic reforming process—Hydroforming. The second type, Platforming, was not put into commercial operation until 1949. Even by the end of 1951, reforming furnished only about 100,000 daily barrels, and most of this was spurred into existence by the demands for toluene for World War II.

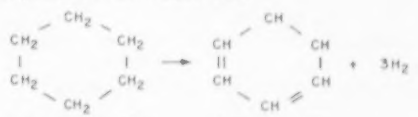
The first announcements of catalytic reforming were followed by many more until now there are 15 processes devised for reforming naphthas and gasolines for octanes. Two of the latest of these—Iso-Plus and Rexforming—combine aromatic separation and raffinate recycle to achieve higher octanes.

The phenomenal growth in reforming is linked directly with the equally phenomenal growth in octanes. Aside from the flurry of special additives and "mouse milks" which dominated the gasoline market in the early part of the 1950's, octanes have been the primary basis for competition.

In 1947, many of the high-octane components, which had previously gone into aviation gasoline for the war, were diverted to civilian gasoline. The auto industry seized on this first increment of octane increase to design engines with higher compression. Each increase in compression of automobile engines created a demand for high octane gasolines, and by the same token, each octane increase paved the way to higher compression engines. And thus the octane race was on.

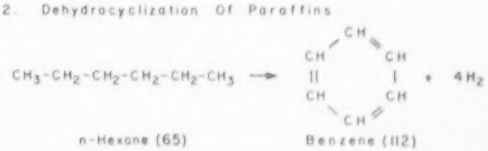
Some typical reactions are shown here to exemplify primarily what happens during reforming. The numbers in parentheses are the F-1 octanes of the compounds at 3cc TEL.

1. Dehydrogenation Of Naphthenes



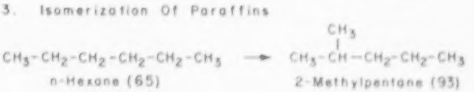
Cyclohexane (97) Benezene (112)

2. Dehydrocyclization Of Paraffins



n-Hexane (65) Benzene (112)

3. Isomerization Of Paraffins



n-Hexane (65) 2-Methylpentane (93)

The continuing rise in octane of motor fuel paints a bright future for reforming. Some are predicting an *average* F-1 octane for premium gasoline of 100 by 1960. Even now, several brands on the market have reached this rating; however, the average is only 97. There is little doubt that the 100 goal will be reached soon, and more and more reformers will be constructed to do it.

Compare Catalytic Reforming Processes

NAME	CATALYST			Regeneration	OPERATING CONDITIONS		First U.S. Unit On-stream
	Composition	Form	Bed Type		Temp. °F.	Press., psig	
Cycloversion[1]	Bauxite	pellets	fixed	cyclic	950–1000	50–57	April, 1940
Fixed-Bed Hydroforming	MoO_3/Al_2O_3	pellets	fixed	cyclic	1000	150	Nov., 1940
Platforming	Pt/Al_2O_3	pellets	fixed	none	900	750	Nov., 1949
Catforming	Pt/Al_2O_3	pellets	fixed	occasional	920	500	Aug. 1952
Fluid Hydroforming	MoO_3/Al_2O_3	powder	fluid	separate	890–940	200	Dec., 1952
Houdriforming	Pt/	pellets	fixed	Occasional	950	300	Nov., 1953
Ultraforming	Pt/Al_2O_3	pellets	fixed	cyclic	900–950	200–500	May, 1954
Sinclair-Baker-Kellogg	Pt/Al_2O_3	pellets	fixed	cyclic	825–950	200–500	Sept., 1954
Sovaforming	Pt/	pellets	fixed	occasional	.....	.....	Nov., 1954
Thermofor Catalytic	Cr_2O_3/Al_2O_3	beads	moving	separate	950–1000	100–200	Mar., 1955
Orthoforming	MoO_3/Al_2O_3	powder	fluid	separate	.....	.....	April, 1955
Hyperforming	Cobalt Moly	pellets	moving	separate	870	400	May, 1955
Powerforming	Pt/	pellets	fixed	cyclic	.....	.....	July, 1955
Rexforming	See Platforming	.....	.....	.....	.....	.....	April, 1956
Iso-Plus	See Platforming	.....	.....	.....	.....	.....	None[2]

[1] First units used for desulfurization.
[2] Unit on-stream June, 1956, for Societa Azionaria Reffinazione Olii Minerali in Ravenna, Italy.

Catforming—THE ATLANTIC REFINING COMPANY

Application—Atlantic Catforming is a selective catalytic reforming process for the conversion of low-octane naphthas into finished high-octane gasoline and for the production of aromatics for petrochemicals and aviation gasoline. The catalyst promotes the following chemical reactions: isomerization of paraffins and naphthenes, cyclization of paraffins, conversion of naphthenes to aromatics, hydrocracking of high-boiling paraffins, and desulfurization by conversion to hydrogen sulfide.

Charge—Feed stocks may be high-sulfur, wide-boiling-range (up to 400 F.) straight-run naphthas, hydrogenated cracked naphthas, or selected cuts for special aromatics production.

Product—During motor gasoline operation the reactor product requires only stabilization before inclusion in finished gasoline. No rerunning, sweetening, or other finishing treatment is required.

Description—Naphtha is usually charged to the reaction section without any feed preparation facilities. For high-severity operations hydrogen treating is recommended. The feed is joined with a recycle gas stream and preheated by exchange with the final reactor effluent. The mixture is then heated to reaction temperature in a furnace, and passed through three fixed-bed reactors in series. Reheaters between reactors are used to compensate for the endothermic heat of dehydrogenation. The final reactor effluent, after exchange with the feed, is condensed in a cooler and separated from hydrogen recycle and make gas in a high pressure flash drum. Recycle hydrogen is compressed and returned to the reactors, while net hydrogen production is vented from the unit under pressure control. The hydrogen, of 90 to 95 percent purity, is useful for many other refinery processes. Liquid from the flash drum flows to a conventional stabilizer.

For high-sulfur stocks desulfurization facilities are justified. In catforming this is usually accomplished by a conventional amine absorber on the recycle gas. Since neither nitrogen nor water is a catalyst poison, no water washing or glycol scrubbing is required following the absorber. For high-severity operations, hydrodesulfurization before Catforming becomes economical.

Carbon is deposited on the catalyst very gradually during normal operations. After a long run the catalyst may be restored to initial activity by burning off the carbon deposit with a dilute mixture of air and steam. The ability to regenerate simply and quickly also saves the catalyst if a major upset deposits a substantial amount of carbon.

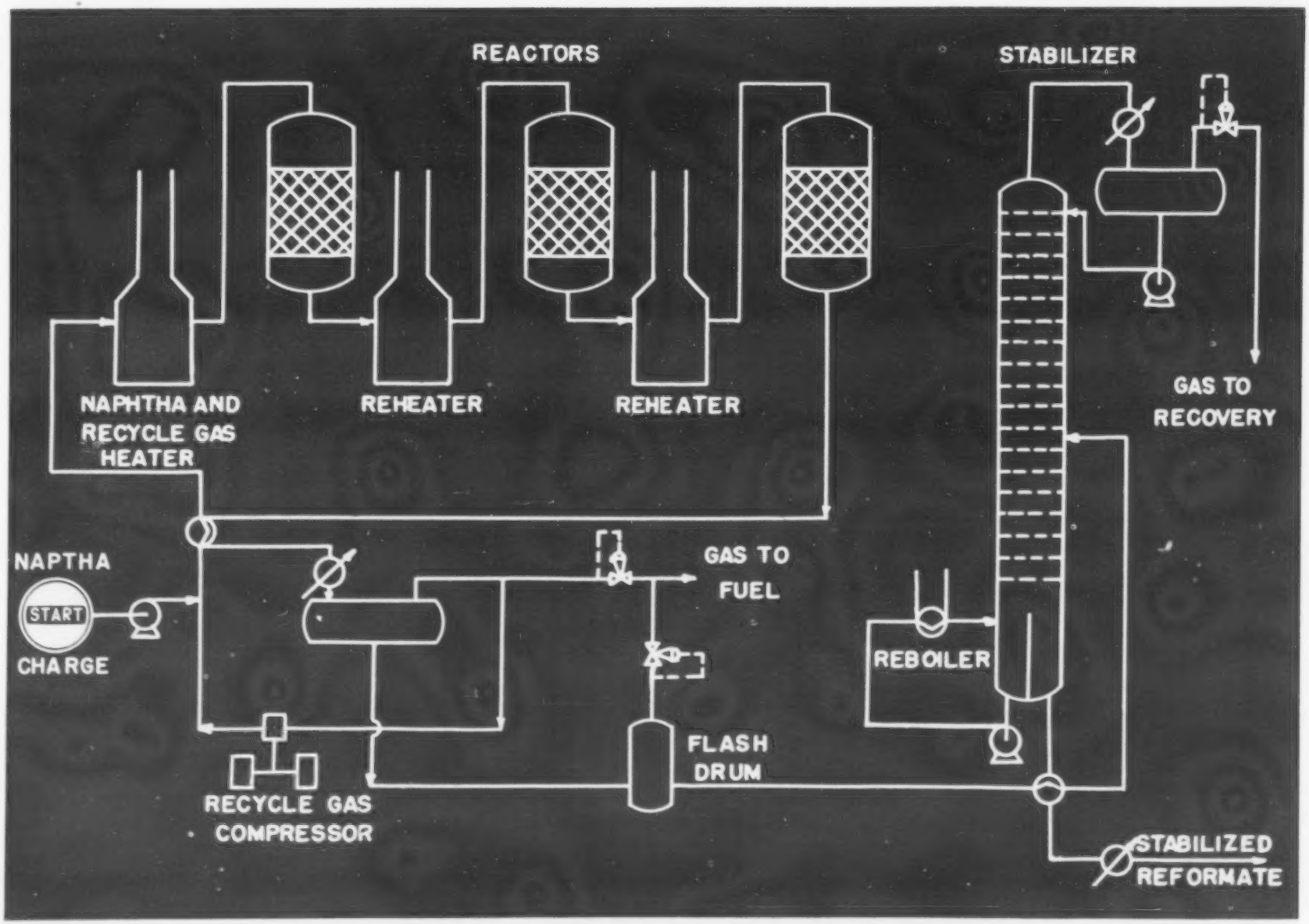
Operating Conditions—Reactor temperature is 850-950 F., while the pressure is maintained at 300-700 psig. Product yields and qualities will depend to a large extent on the properties of the feed and the operating severity employed.

Yields—Typical charges, yields, and inspections are shown in the accompanying table. The column for Kuwait naphtha represents experimental data on a new catalyst which permits operation at 95 to 100 clear octane in conventional three-reactor Catformers. Commercial trials of this new catalyst are now under way.

Commercial Installations—Since the first commercial operation of the Catforming process began in August, 1952, twenty-three additional units have been completed and put in operation. These and many other units in various stages of design and construction are operating or will operate on widely variant feed stocks. Capacities of the units range from 300 to 15,000 barrels per day.

Reference—PETROLEUM REFINER, vol 34, no 9, p 169 (Sept, 1955).

STOCK	East Texas		Arabian		California		Kuwait	
Charge Stock:								
ASTM—10 Percent	236		268		284		288	
50 Percent	268		294		319		300	
90 Percent	317		334		365		320	
Sulfur, Wt. %	.005		.03		.028		.04	
F—1 Octane Clear	51.5		37.4		54.0		31.9	
Products:								
Debut. Gaso.—Vol.%	86.7	84.4	84.6	75.7	93.5	88.0	77.8	71.1
C_4—Vol. %	6.3	8.2	11.3	17.2	2.6	6.1	.....	19.1
C_3—Wt. %	2.5	3.4	4.0	6.3	1.2	2.2	.....	7.6
C_2—Wt. %	0.3	0.4	0.7	2.2	0.1	0.5	.....	1.8
C_1—Wt. %	0.1	0.2	0.2	0.6	0.1	0.3	.....	0.5
H_2—Wt. %	1.9	1.9	0.5	0.5	1.3	1.7	.....	0.6
RVP Debut. Gaso.	2.4	2.7	2.4	3.7	1.6	2.5	.....	6.0
F—1 Octane—10 PSI RVP.:								
Clear	89.9	92.9	86.4	93.0	83.9	93.6	95.0	99.0
3cc TEL	97.8	99.2	96.3	99.8	94.3	99.6	101.9	104.3
ASTM—10 Percent	201	187	184	160	259	212	.....	150
50 Percent	261	258	279	263	316	309	.....	290
90 Percent	329	323	342	354	377	380	.....	339
Sulfur, Wt. %	.001	.001	.001	.001	.001	.001	.....	.001


REACTORS
STABILIZER
NAPHTHA AND
RECYCLE GAS
HEATER
REHEATER
REHEATER
GAS TO
RECOVERY
NAPTHA
START
CHARGE
GAS TO
FUEL
REBOILER
FLASH
DRUM
RECYCLE GAS
COMPRESSOR
STABILIZED
REFORMATE

Cycloversion—PHILLIPS PETROLEUM COMPANY

Application—Cycloversion is used (1) to desulfurize straight run and cracked gasolines, naphtha fractions and kerosines, (2) to reform straight run gasoline or naphtha in order to upgrade octane numbers and to improve lead susceptibility, (3) to catalytically crack gas oil stocks for the production of high octane gasoline. Desulfurization is particularly applicable in preparation of feed stocks for catalytic reforming operations.

Charge—Under desulfurization conditions the charge stocks can be either a full boiling range gasoline or a naphtha fraction. Various mixtures of cracked and straight run charge stocks can be processed in a combined operation. Under reforming conditions the charge stocks are similar to those processed to effect desulfurization. Gas oil cracking charge stocks having a boiling range 400-800 F. can be satisfactorily processed.

Product—Catalytic desulfurization of the straight run or natural gasoline charge stocks results in no appreciable change in the composition of the treated product other than the reduction of sulfur content. With cracked gasoline the octane improvement is due to desulfurization and some isomerization. The absence of undesirable side reactions is indicated by the fact that there is no appreciable change in physical properties such as vapor pressure, gravity or distillation characteristics.

Benefits gained by catalytic reforming include those obtained from catalytic desulfurization together with an appreciable increase in clear and leaded octane ratings.

Catalytic gas oil cracking yields highly olefinic gases, high octane motor fuel, low pour point recycle stocks and bottoms.

Description—The accompanying simplified flow diagram shows the basic equipment included in a Cycloversion Unit. The heater and heat exchangers are of conventional design and serve to heat the feed stock to the desired temperature with a minimum of thermal decomposition. Two reactors are provided for continuous operation, i.e., one chamber is on process while the other is being regenerated. The rerun and stabilization facilities are also conventional in design. The steam superheater and air compressor are regeneration facilities which are used for reactivating the catalyst in situ. An installation of this type can be used for any of the applications of Cycloversion. However, rerun and stabilization facilities are not required for straight run desulfurization. Also, some units built for desulfurization service, have only a single reactor and do not include regeneration facilities. These installations discard the catalyst when it is spent and recharge the reactor with new catalyst.

All the equipment shown in the flow diagram is required for gas oil cracking and reforming operations. The higher carbon deposition on the catalyst for either of these operations precludes the use of the non-regenerative unit. Process cycles vary from three to 12 hours when processing gas oil and from 12 to 72 when reforming. Steam is added with the gas oil charge to suppress carbon deposition on the catalyst but is not generally used in the desulfurization or reforming operation.

Caustic washing facilities are generally provided to remove the H_2S formed when the sulfur compounds are decomposed. No further treatment is usually necessary.

The catalyst is cyclocel grade bauxite and is a natural occurring material. It has a life of 5000-20,000 barrels per ton when used in non-regenerative desulfurization units and 50,000-100,000 barrels per ton when used in regenerative units.

Operating Condition—The major process variables are temperature, pressure, and space velocity. High temperatures increase the depth of conversion. Lower pressures increase the olefinicity of the gasoline obtained from gas oil cracking which in turn increases the octane rating of the product. Increasing space velocity at constant temperature and pressure decreases the depth of conversion.

Yields—In the desulfurization operations, the yields are 98.0-99.5 liquid volume percent of charge. Yields from reforming are dependent on the severity of the operation. This is also true for gas oil cracking though in this operation a 50 percent conversion is considered normal. Typical data for the three types of operation which can be performed in the Cycloversion process are shown in the tables below.

Commercial Installations—The first Cycloversion unit was installed in 1940. At present there are 32 units in operation with a total designed thruput of over 100,000 barrels per day. These units range in size from 300-20,000 barrels daily.

TABLE 1
Cycloversion of Mid-Continent Gas Oil

Feed Stock:		
Gravity, API°	32.2	
10 Percent (Vacuum)	604	
90 Percent (Vacuum)	752	
Aniline Point, °F	181	
Catalytic Gasoline, C₅—400° F	Test 1	Test 2
Gravity, API°	55.1	54.9
Reid Vapor Pressure	6.0	6.6
ASTM Octane Number	80.4	81.1
+3 cc. TEL	84.5	84.7
Research Octane Number	94.3	94.5
+ 3 cc. TEL	97.8	98.0
Yields, Percent of Charge:		
Cat. Gasoline, C₅-400° F., Vol. Percent	28.6	33.2
10 Lb. RVP., Gasoline, Vol. Percent	37.4	42.9
Propylene, Vol. Percent	4.1	4.2
Butylenes, Vol. Percent	4.9	5.6
Cat. Recycle 400° F., +Vol. Percent	59.1	50.7
Carbon, Weight Percent	1.5	2.3
Conversion, Single Pass Vol. Percent	40.9	49.3

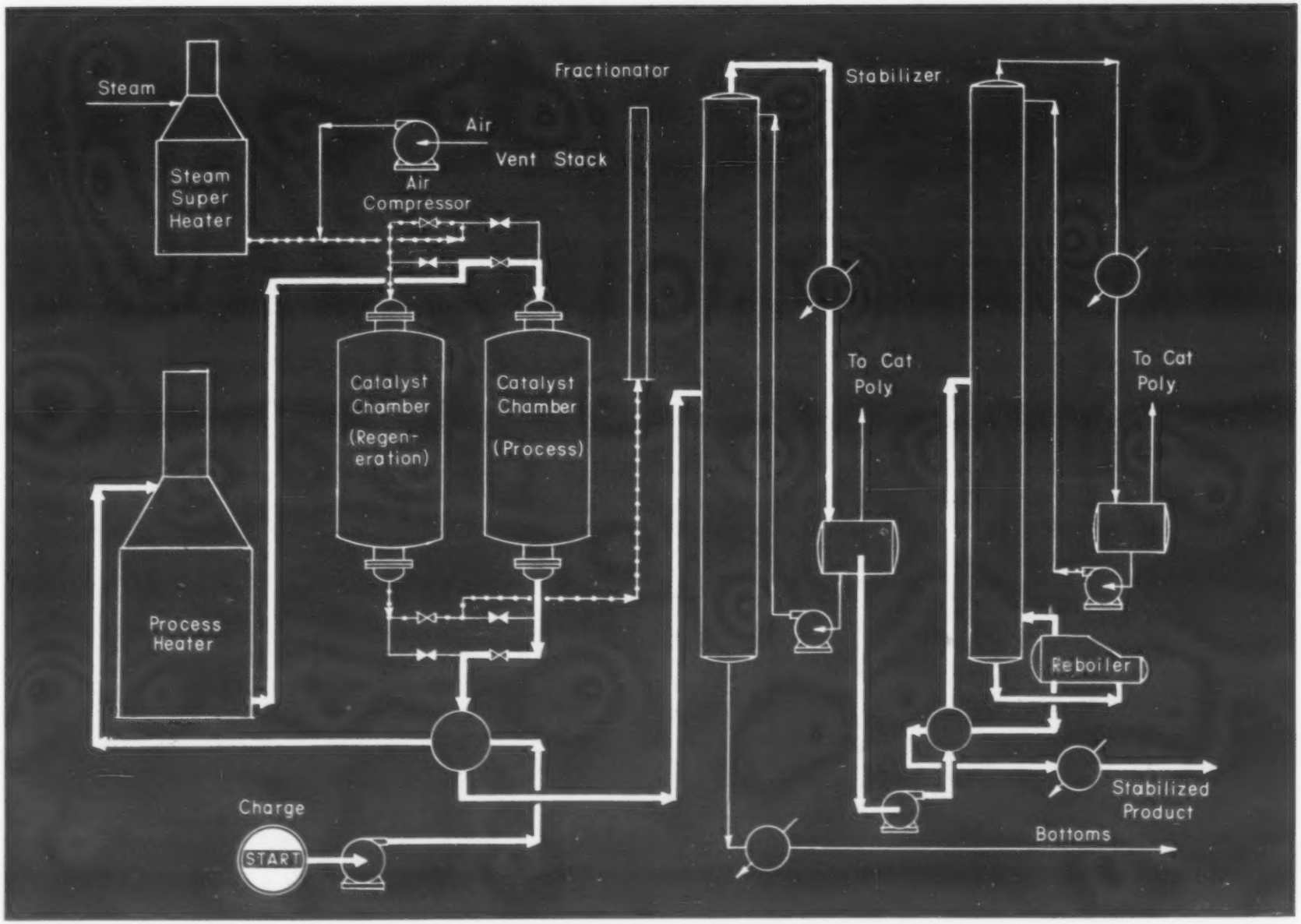
* Butanized and includes potential catalytic poly gasoline.

TABLE 2—Reforming

Sample Designation		Debutanized Reformed Naphtha	
Test Number	Charge	One	Two
Operating Conditions:			
Space Velocity, V/V/Hr	....	1.0	1.0
Cat. Chamber Inlet, °F	....	875	974
Cat. Chamber Pres., Psig	....	50	50
Yield Summary:			
Debut. Ref. Naph., Vol. Percent Charge	....	95.6	88.7
Research Octane Ratings:			
Clear	42.7	52.2	68.0
Plus 1.0 cc. TEL/Gal	51.0	62.3	75.4
Plus 3.0 cc. TEL/Gal	59.4	73.3	83.3
API Gravity @ 60 F	46.9	46.3	46.1
R.V.P.	1.5	1.1	3.2
Total Sulfur, Weight Percent	0.184	0.011	0.020
ASTM Dist. °F.:			
First Drop	271	187	129
10 Percent	312	297	259
30 Percent	324	320	309
50 Percent	334	333	327
70 Percent	346	348	344
90 Percent	365	370	367
End Point	416	429	442

TABLE 3—Desulfurization

	Straight-Run Gasoline	
	Charge	Product
Operating Conditions:		
Space Velocity, V/V/Hr	....	1.0
Cat. Chamber Inlet, °F	....	803
Cat. Chamber Pres., Psig	....	50
Research Octane Ratings:		
Clear	64.2	66.3
Plus 1.0 cc. TEL/Gal	71.5	76.6
Plus 3.0 cc. TEL/Gal	78.1	85.5
Yield Summary:		
Yield, Vol. Percent Charge	....	99.6
API Gravity @ 60° F	64.6	63.9
R.V.P.	11.1	10.7
Total Sulfur, Weight Percent	0.123	0.004
Mercaptan Sulfur, Weight Percent	0.049	0.001
Doctor Test	Sour	Sweet
ASTM Dist. °F.:		
First Drop	94	96
10 Percent	117	131
30 Percent	171	176
50 Percent	207	203
70 Percent	239	239
90 Percent	281	278
End Point	339	343


Steam
Steam Super Heater
Air
Vent Stack
Air Compressor
Fractionator
Stabilizer
Catalyst Chamber (Regen-eration)
Catalyst Chamber (Process)
To Cat Poly
To Cat Poly
Process Heater
Reboiler
Charge
START
Stabilized Product
Bottoms

Fluid Hydroforming—THE M. W. KELLOGG COMPANY

Application—The Fluid Hydroforming process is used to catalytically reform straight run and thermically cracked naphthas, or mixtures, to high octane levels.

Charge—A wide variety of either straight run or cracked naphthas or mixtures can be used as feed stock to the unit. A typical boiling range for these naphthas may be considered as 200 to 400 F. although other stocks including higher boiling fractions may be reformed. Some inherent advantage in yield is obtained by using highly naphthenic or aromatic naphthas, but extremely high octane products can also be obtained from paraffinic and olefinic naphthas. High sulfur naphthas can be processed successfully without extraneous desulfurization systems.

Product—Fluid hydroformate has both high octane and high aromatic content. It can therefore be used either as a high octane blending agent for motor or aviation gasoline or as a source of aromatic petrochemicals. The plants now operating will produce debutanized products having 85 to 98 CFRR clear octane ratings.

Description—The naphtha charge is preheated in one coil of a combination furnace and hydrogen recycle gas is heated in a separate coil. The hydroforming reaction occurs in the reactor vessel, where the combined vaporized naphtha charge and hydrogen-rich recycle gas contact a fluidized bed of catalyst.

Carbon deposited on the catalyst by the reaction is burned off with air in a regeneration chamber. Much of the heat generated by combustion is utilized to produce steam in boiler tubes within the regenerator. The beds of catalyst in each of these vessels are kept in a fluid state by the upward passage of naphtha vapor and recycle gas in the reactor, and combustion air in the regenerator.

Some catalyst is carried out of the fluid beds by the rising vapor. The bulk of this entrained powder settles out in the "disengaging space" and falls back into the bed. Further catalyst recovery is effected by cyclone separators in the top of the reactor and regenerator. Flue gas leaving the regenerator goes to atmosphere. Product vapors and gas flow from the reactor cyclones to a recovery system.

Catalyst is continually recirculated between the two vessels. "Spent" catalyst is carried through an internal riser pipe from the bottom of the reactor to a hopper-stripper located atop the vessel. A stream of recycle gas acts as conveying medium. From the hopper-stripper powder flows by gravity into the regenerator. Gravity flow of regenerated catalyst to the reactor completes the circuit. This circulation system makes possible close control of catalyst properties at all times. Fresh catalyst can be added when required, and used catalyst can be withdrawn while the unit is in continuous operation. By using a circulating catalyst system, high octane levels can be attained without the possibility of shutdown due to excessive coke, poisoning or physical damage to the catalyst.

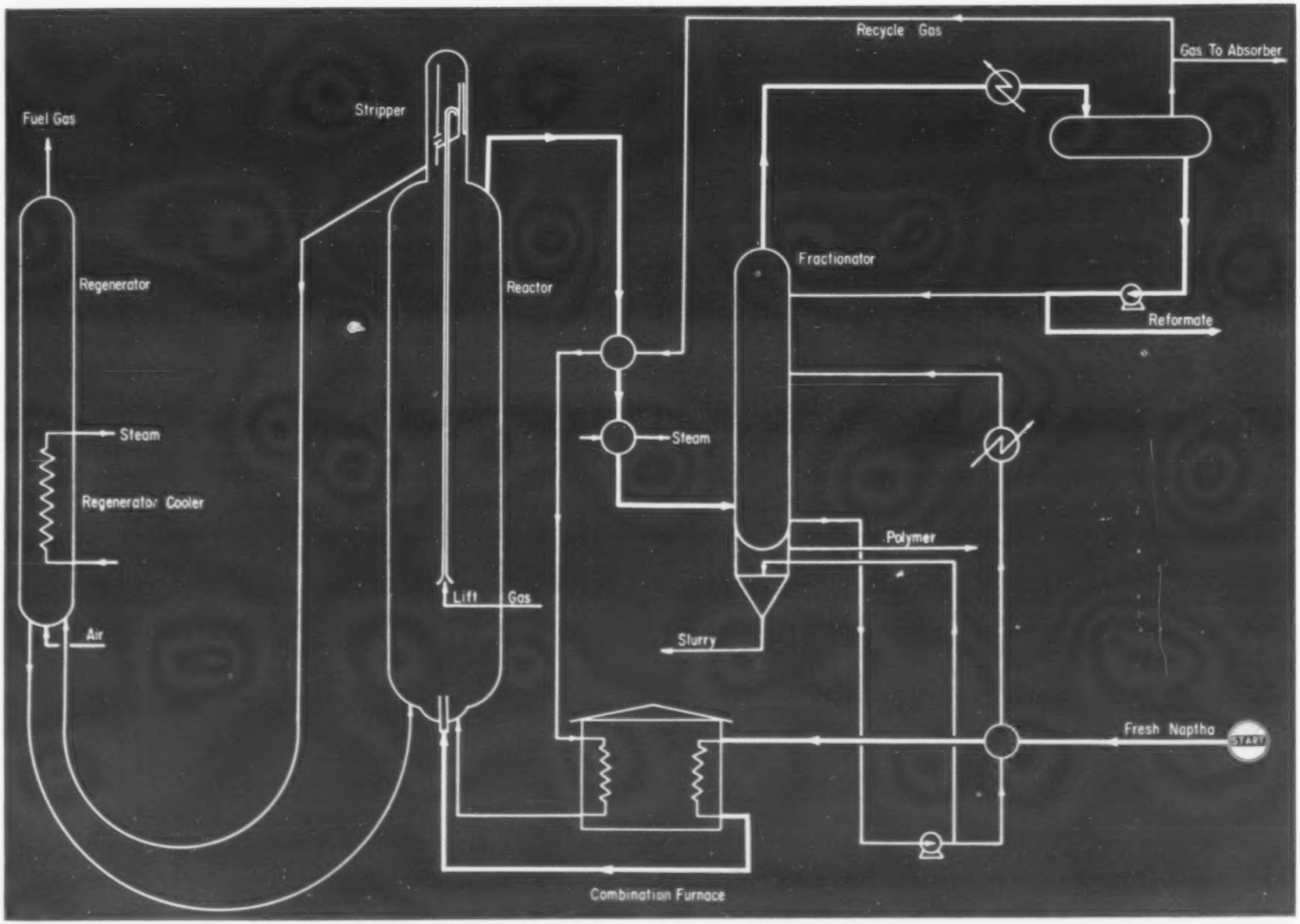
Operating Data—Yield and product quality data from commercial operations in fluid hydroformers have verified earlier pilot plant predictions. The process shows an extremely high octane potential, producing a debutanized reformate with as much as a 98 clear research octane rating. Flexibility has been demonstrated by commercial operation ranging from 55 to 130 percent of design capacity.

Operating conditions may vary over the following approximate ranges:

Reactor pressure	200-500 psi
Reactor temperature	900-950 F.
Regenerator pressure	210-510 psi
Regenerator temperature	1000-1100 F.
Hydrogen recycle gas rate	4000-8000 scf/bbl.
Space velocity	0.30-0.80 W/Hr./W
Catalyst to oil ratio	0.25-1.00 W/W

Commercial Installations—A 2000 barrel-per-day plant is in operation at Destrahan, La., a 13,000 barrel-per-day plant at East Chicago, Ind., and a 17,500 barrel-per-day plant at Lake Charles, La., producing high quality motor and aviation gasoline components.

Reference—PETROLEUM REFINER, vol 32, no 10, p 135 (Oct., 1953).


Recycle Gas
Gas To Absorber
Fuel Gas
Stripper
Fractionator
Regenerator
Reactor
Reformate
Steam
Steam
Regenerator Cooler
Polymer
Lift Gas
Air
Slurry
Fresh Naptha
START
Combination Furnace

Powerforming—ESSO RESEARCH AND ENGINEERING COMPANY

Application—Powerforming is a fixed-bed cyclic process employing a newly-developed platinum catalyst. It is used to produce high-octane gasoline. The hydrogen-rich tail gas from a Powerformer may be used for removing sulfur from the Powerformer feed stock and from other distillate stocks.

Charge—Typical feed consists of a low-octane virgin naphtha or a cracked naphtha-virgin blend. Excellent results have been obtained with blends containing fluid coking naphtha. Hydrofining of feed stocks is not necessary, but is generally preferred.

Product—Materials with 95-100 octane number can be produced from a wide variety of feed stocks.

Description—Powerforming uses four, five or six reactors with three, four or five on stream while one is being regenerated by a special technique. The cycle on any one reactor varies from 5 to 15 days.

Due to the new regenerating technique, the catalyst retains its high initial activity over long periods of operation.

Feed for the process first passes to a Hydrofiner for hydrogen treat. This step can be omitted if a saturated, straight-run sweet naphtha is being used, but it is necessary with cracked fuel naphtha or blends containing these components.

Effluent from the Hydrofiner passes to an absorber stripper. Bottoms from the absorber stripper then proceed to the first of the Powerforming reactors. Powerforming feed passes through at least three of the reactors in series, and may be passed through as many as five.

Effluent from the last Powerforming reactor is cooled and sent to a separator. A gas rich in hydrogen is taken from the separator and split in two streams. One goes to the absorber stripper and the other is used as recycle for the Powerforming reactor. Bottoms from the separator are heated and fed to a debutanizer.

Yield—See Table 1.

Commercial Installations—Three Powerformers were in operation by the middle of 1956, the first having started up in July, 1955. Two others are scheduled to start up before the end of 1956. Fifteen more units are planned for after 1956. These units, with a combined capacity of 156,400 barrels per stream day, are listed in Table 2.

TABLE 1
Typical Powerforming Operations

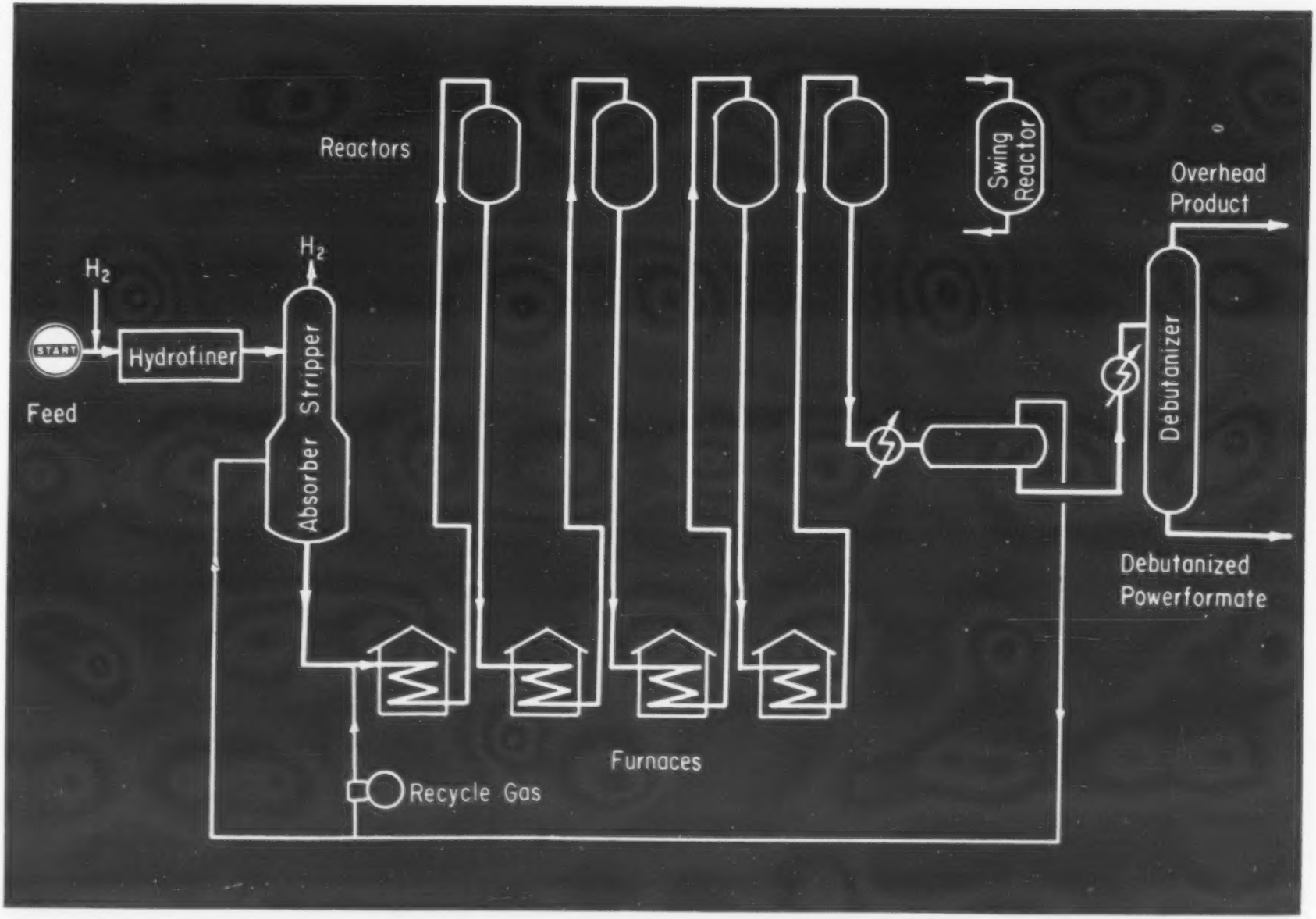
YIELDS	Light Arabian	Heavy Arabian	Mixed Louisiana	Heavy W. Tex.
FEED STOCKS				
Gravity, °API	61.9	54.0	60.3	50.6
Sulfur, wt. %*	0.03	0.07	0.005	0.20
F-1 octane, clear	39	29.7	53	46.1
Distillation:				
10 percent	216	276	205	288
50 percent	241	326	231	308
90 percent	282	370	293	350
YIELDS lb PRODUCT QUALITY				
Research octane:				
Clear	95	100	98	98
+ 3cc. TEL	100.5	103	103	102
Motor octane:				
Clear	85.5	88.5	88	87
+ 3cc. TEL	92	93.5	93	92
Yields:				
C_5 +, vol. percent	72.5	69	72.5	81
C_4, vol. percent	10.5	11.5	10.5	6.5
C_1-C_3, wt. percent	12.5	16.5	12	8.5
H_2, wt. percent	1.4	0.7	1.8	1.8
H_2, SCF/B	680	350	880	930

*Before Hydrofining

TABLE 2
COMMERCIAL POWERFORMING INSTALLATIONS

COMPANY	Location	Capacity B/SD	Startup Date
Esso Std. Oil Co.	Baltimore, Md.	3,000	July '55
Imperial Oil Ltd.	Edmonton, Alba.	2,200	Aug. '55
Carter Oil Co.	Billings, Mont.	2,500	Feb. '56
Imperial Oil Ltd.	Halifax, N.S.	7,000	(Aug. '56)
Imperial Oil Ltd.	Sarnia, Ont.	15,000	(Sept. '56)
Imperial Oil Ltd.	Montreal, Quebec	9,000	(1957)
*Raffineria Garrone	Genoa, Italy	3,300	(1957)
*Rasiom	Augusta, Sicily	5,600	(1957)
International Refineries, Inc.	Wrenshall, Minn	2,800	(1957)
Esso Std. Oil Co.	Linden, N.J.	20,000	(1957)
Esso Std. Oil Co.	Everett, Mass.	7,200	(1957)
Stanic	Bari, Italy	7,300	(1957)
Imperial Oil Ltd.	Ioco, Brit. Col.	4,000	(1957)
Esso Italiana	Trieste, Italy	1,000	(1957)
Esso Std. Oil, S.A.	Belot, Cuba	2,500	(1957)
Esso Std. Oil Co.	Baton Rouge, La.	26,900	(1957)
Esso Std. Soc. An. Fr.	Pt. Jerome, France	14,500	(1958)
Esso Std. Refinery, S.A.	Antwerp, Belgium	5,600	(1958)
Esso A.G.	Cologne, Germany	9,000	(1959)
Esso Std. Soc. An. Fr.	Bordeaux, France	8,000	(1959)
Total		156,400	

*Licensee unit.


Reactors
Swing Reactor
Overhead Product
H_2
H_2
START
Hydrofiner
Absorber Stripper
Debutanizer
Feed
Debutanized Powerformate
Furnaces
Recycle Gas

SBK Catalytic Reforming—THE M. W. KELLOGG COMPANY

Application—This process is applied to the upgrading of low-octane naphthas.

Charge—Light, heavy and full-boiling range naphthas, including those from high-sulfur crudes, have been reformed successfully.

Product—Motor fuel blending stock of 85-100+ octane (research clear), depending upon operating conditions.

Description—The accompanying flow diagram illustrates a typical commercial design. Naphtha is charged through an absorber to a high pressure desulfurizer, along with hydrogen produced in the unit, for removal of harmful metallic, nitrogen and arsenic compounds, desulfurization, and saturation of olefinic compounds. The desulfurizer effluent passes through a stripper, is joined by hydrogen-rich recycle gas, and receives preheat to reforming temperature prior to entering the first reforming reactor.

After the first reactor, the vapors are reheated and passed to the second reactor. Following the second reactor, the vapors are reheated again and passed to the third and/or fourth reactor. The effluent from the final reactor is passed through reboilers and coolers to the high pressure separator where the total reactor effluent is separated into liquid and gas fractions. The gas, high in hydrogen content, is compressed and recycled to the inlet naphtha feed system. The liquid fraction is fed to a column for stabilization to produce the debutanized reformate product. Hydrogen is produced in excess of process requirements and may be utilized in other processes.

Catalyst is regenerated in place. Either the third or fourth reforming reactor may be shut down for regeneration with no marked disturbance to the operation.

Operating Conditions—The preferred range of reactor conditions is 300-500 psig and 875-950 F, with a recycle gas rate of 5000-8000 SCF/Bbl feed.

Yields—The following data give typical yields for reforming an East Texas virgin heavy naphtha of 250-390 F boiling range, 50 F-1 clear octane number.

F-1 clear octane (C_5+)	85	90	95
Yield, C_5+ reformate, vol.%	91.0	88.2	84.7
Yield, C_4's, vol. %	2.2	3.0	4.0
Yield, dry gas, wt.%	4.7	6.0	7.7

Data for reforming Middle East paraffinic virgin heavy naphtha are:

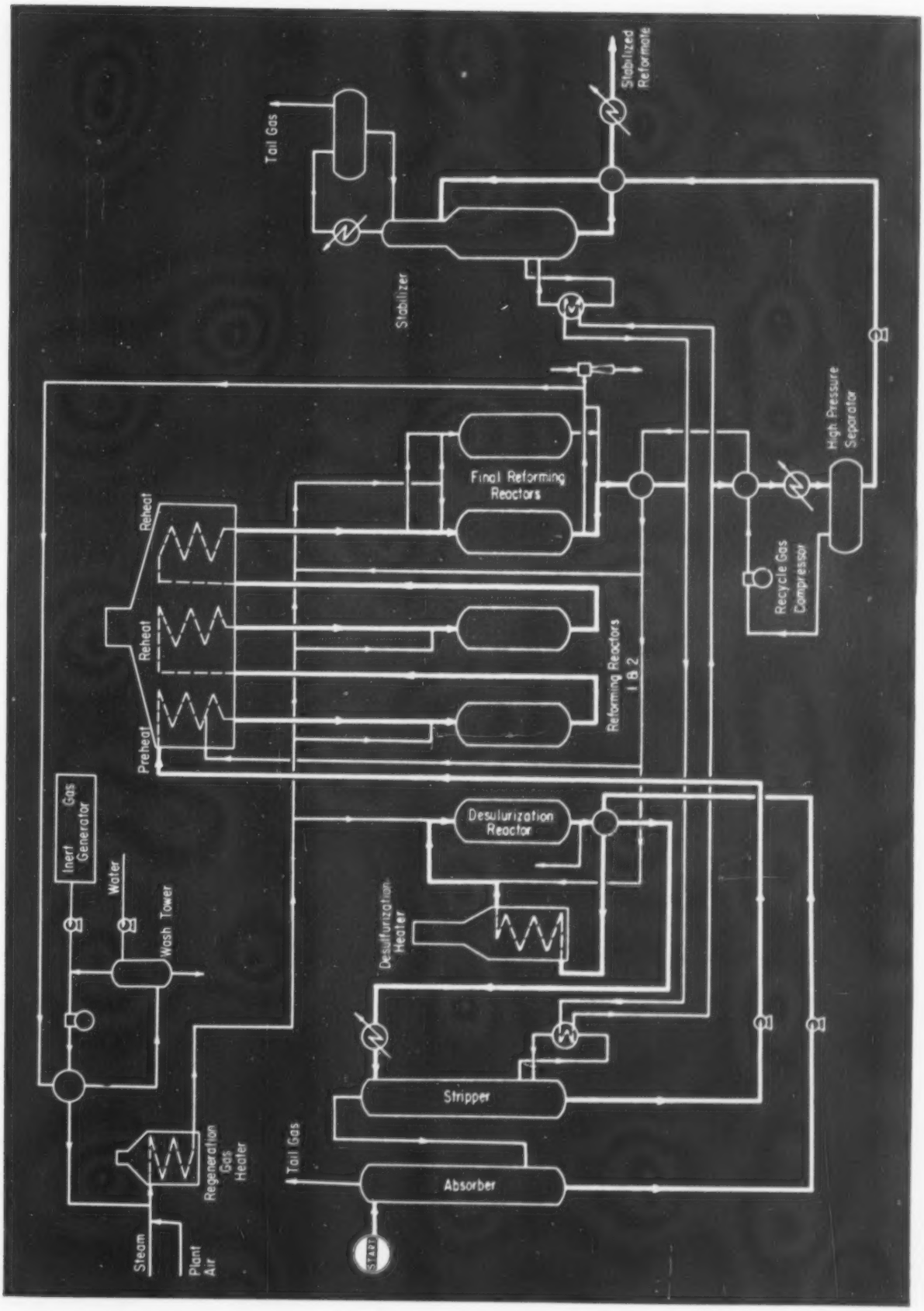
Feedstock		
Gravity, °API		52.8
ASTM Distillation, °F		
IBP		250
10%		293
50%		323
90%		360
EP		385
F-1 clear octane		25.9
F-1 + 3cc TEL.		51.1
Reformate	Case A	Case B
Yield C_5+ reformate, vol.%	78.5	80.8
Yield C_4's vol.%	6.4	5.8
Yield dry gas, wt.%	10.5	9.2
F-1 clear octane (C_5+)	95	95
Operating Conditions		
Pressure	high	low
Reactor temperature	900	900
Recycle gas rate, SCF/Bbl.	5000	5000

Economics—Installation costs are $125-300 per barrel for capacities from 3000 to 30,000 bpsd. Typical operating costs for a 10,000 bpsd unit are given below.

Feedstock Source	Kuwait		Mid-Continent	
Product octane—F-1 clear C_5+	90	95	90	95
Operating cost, ¢/bbl. feed				
Fuel @ $0.90/bbl.	5.2	5.2	5.2	5.2
Power @ $0.007/KWH	2.0	2.3	2.0	2.0
Water @ $0.007/1000 gal.	0.5	0.6	0.5	0.5
Catalyst (reforming)	6.8	10.8	4.0	6.7
Catalyst (desulfurizing)	0.5	0.5	0.5	0.5
Labor @ $55/day	1.4	1.7	1.4	1.4
Supervision @ 15% Labor	0.2	0.2	0.2	0.2
Total direct operating cost	16.6	21.3	13.8	16.5
Maintenance @ 4% process equipment investment	2.2	2.5	2.2	2.3
Property taxes & insurance @ 2% process investment	1.5	1.8	1.4	1.6
Interest @ 4% total process investment	3.0	3.6	2.8	3.2
Depreciation @ 10% process equipment investment	5.5	6.2	5.5	5.7
Total operating cost, ¢/bbl. feed	28.8	35.4	25.7	29.3

Commercial Installations—Eleven units of Kellogg design are operating or under construction, having a total charge capacity of 111,700 bpsd. Industry-wide, 38 reforming units have been or are being designed for Sinclair-Baker catalyst, representing a combined charge capacity of 357,300 bpsd.

Reference—PETROLEUM REFINER, vol 34, no 9, p 190 (Sept, 1955).


Stabilized Reformate
Tail Gas
Stabilizer
High Pressure Separator
Final Reforming Reactors
Reheat
Reheat
Preheat
Reforming Reactors 1 & 2
Recycle Gas Compressor
Desulfurization Reactor
Desulfurization Heater
Inert Gas Generator
Water
Wash Tower
Stripper
Absorber
Tail Gas
Regeneration Gas Heater
Steam
Plant Air
START

Thermofor Catalytic Reforming—SOCONY MOBIL OIL COMPANY, INC.

Application—The Thermofor Catalytic Reforming process is used to produce low sulfur, high octane gasoline products for motor and aviation purposes.

Charge—The charge to TCR units generally consists of low octane, hydrocarbons boiling in the gasoline range. High sulfur cracked stocks may be processed without pretreatment for sulfur removal.

Product—The TCR product is a high quality low sulfur gasoline having octane numbers in the 100 F-1, leaded, range.

Description of Process—Referring to the flow diagram, the naphtha charge flows down through an absorber to attain the desired recovery of light hydrocarbons. The enriched feed is then heat exchanged against reactor effluent, heated to about 900 F., and charged into the reactor together with the heated recycle gas.

The TCR reactor contains a compact, downwardly moving bed of catalyst into the center of which is fed the heated mixture of naphtha and recycle gas. The effluent products from the top and bottom are combined, cooled by heat exchange, finally water and then flashed.

The flashed gas is compressed and recontacted at higher pressure with the primary condensate, after which it is cooled and reflashed. This secondary off gas forms the recycle stream while the net makes flows to the absorber for light hydrocarbon recovery. The absorber off gas is then sent to the refinery fuel system or may be used in subsequent processes. The recycle gas may be dried and heat exchanged before being reheated and fed to the reactor.

Because a small amount of high boiling polymer is formed in the reaction, the reformate is rerun. It is expedient to separate the small yield of polymer in a two tower rerun system producing light and heavy reformates.

Besides the reactor, the catalytic section of the TCR unit contains the kiln, the catalyst elevating system, a catalyst pressure lock system feeding the reactor, and storage bins. The kiln is similar to those of the bucket-type TCC units and contains alternate burning and cooling sections operating at substantially atmospheric pressure. The elevating system may be of any type but since catalyst circulation rates are low (under 75 tons/hour for a 20,000 bpd unit) commercial units have been built with bucket-type elevators.

Since the kiln is operated at about atmospheric pressure (a safety feature of the design) and the reactor at about 175 psig, a pressure lock system is used for introducing catalyst into the reactor, and a depressuring leg is used at the outlet of the reactor.

The catalyst is a chromia-alumina bead somewhat similar in appearance to the Socony bead cracking catalyst used in TCC units. Ninety-five percent or more of the sulfur in the feed stock is converted to hydrogen sulfide which may be recovered from the recycle and off gas.

Operating Conditions—As noted above, the reactor pressure is usually about 175 psig but may be varied between 100 and 200 psig for best results on different stocks. The gas recycle unit ratio is usually set at about 6 mols (3 of hydrogen) per mol of naphtha. The space velocity is usually set at about 0.7 volumes of naphtha per hour per volume of reaction bed. The reactor temperature is an important variable in controlling the reforming severity and can range from 950 F. to 1050 F. Space velocity can be used interchangeably with reactor temperature to attain the desired octane level.

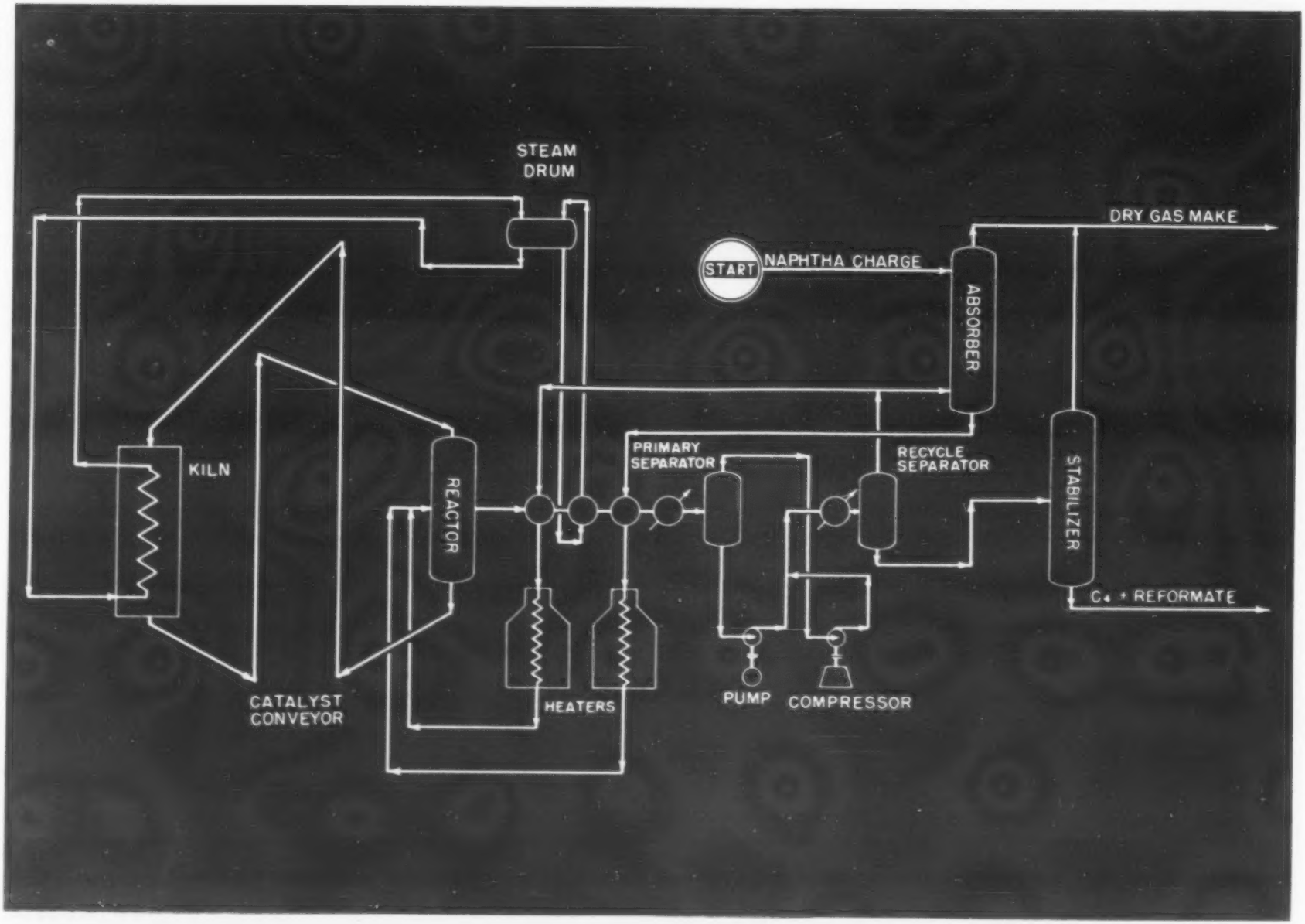
Yields—Typical operations on 200 to 400 F. straight-run naphtha yield 90 percent of 10# RVP gasoline while raising the leaded research octane from 63.2 to 96.7. The accompanying table gives data on yields and sulfur reduction when charging 50 percent of thermally cracked naptha.

Commercial Installations—In 1954, two commercial units were built, one at the Beaumont refinery of Magnolia Petroleum Company and one at the Torrance refinery of General Petroleum Corporation. Both were designed for 19,000 bpd throughput but in actual operation both units have exceeded design capacity.

Reference—PETROLEUM REFINER, vol 31, no 5, p 117 (May, 1952).

COMMERCIAL YIELDS

	A Blend of	
Type of Charge Stock:	**50% Straight Run Naphtha**	**50% Cracked Naphtha**
Properties:		
Boiling range, F	200–400	250–400
Sulfur, weight percent	0.22	1.43
Yields:		
C_4, Volume percent	3.4	
Light reformate, volume percent	56.2	
Octane No. (research + 3 cc. TEL)	94.0	
Sulfur, weight percent	0.03	
Heavy reformate	29.0	
Octane No. (research + 3 cc. TEL)	99.0	
Sulfur, weight percent	0.05	
Polymer, volume percent	1.6	
10-lb. R.v.p. gasoline, volume percent	93.6	


STEAM DRUM
START
NAPHTHA CHARGE
DRY GAS MAKE
ABSORBER
KILN
REACTOR
PRIMARY SEPARATOR
RECYCLE SEPARATOR
STABILIZER
C4 + REFORMATE
CATALYST CONVEYOR
HEATERS
PUMP
COMPRESSOR

Ultraforming—STANDARD OIL COMPANY (INDIANA)

Application—Ultraforming is a regenerative, fixed-bed catalytic reforming process used to convert low-octane naphthas to high-octane blending stocks. It is particularly useful where higher reformate yields and maximum product octanes are required to meet present and future refinery octane goals.

Charge—Either straight-run naphthas or mixtures of straight-run and cracked naphthas may be charged. Because the process has regeneration facilities, boiling range of the charge stock is not critical. Both highly paraffinic and highly naphthenic naphthas can be economically upgraded.

For avgas or aromatics operations, selected fractions of straight-run naphtha may be processed.

Product—Typical commercial operations give reformates of 95-100 Research octane number, clear.

Description—Ultraforming differs from other processes employing platinum catalysts by using lower reaction pressures and a unique catalyst regeneration technique. Lower reaction pressures result in higher reformate yields; onstream catalyst regeneration maintains fresh catalyst activity even when severe reforming conditions are used. An improved catalyst which is stable to repeated regenerations, a unique regeneration technique, and a unique process design involving a swing reactor are some important Ultraforming features. In some situations, it may be desirable to eliminate the swing reactor and employ other arrangements that have been developed for effecting the required Ultraforming-type regeneration.

In the flow diagram, catalyst in the swing reactor is being regenerated while naphtha is being processed in the other three reactors. Naphtha charge and hydrogen-rich recycle gas are passed through a furnace where they are heated to reactor inlet temperature. They are then passed through three reactors in series. The predominant reactions are endothermic and cause a temperature drop across each reactor. Furnaces are therefore installed between the reactor to reheat the mixture. Effluent from the final reactor is condensed and separated into a liquid stream and a hydrogen-rich gas. The liquid is stabilized to the desired vapor pressure and withdrawn as finished reformate. Part of the gas is recycled; the rest can be used as a source of hydrogen for other processes or as fuel.

When catalyst activity in a reactor declines, that reactor is temporarily isolated from the naphtha-processing system and is replaced by the swing reactor. Naphtha processing continues while catalyst in the isolated reactor is regenerated with air and inert gas. After regeneration, the reactor is placed back on stream and the swing reactor is available when another reactor needs regeneration.

In a 21,000 bpd commercial unit, which has now accumulated 18 months catalyst life, Ultraforming catalyst supplied by American Cyanamid Company, has been successfully regenerated about 100 times. Currently the product octane number from this unit is over 100 Research, clear.

Low-pressure operation which is made possible by cyclic regeneration, has several major advantages over conventional platinum-catalyst operation: higher gasoline yields, higher ceiling octane numbers, higher effective catalyst activity, and greater flexibility. In addiiton, low pressure gives higher yields of by-product hydrogen. Furthermore, because the Ultraforming regeneration technique fully restores catalyst activity, the Ultraforming process permits a wide range of operating conditions, recovery from operating upsets, and the use of charge stocks varying widely in character. If excessive coke forms on the catalyst for any reason, the catalyst can be regenerated completely to restore operations to normal.

Operating Conditions—Ultraforming is usually carried out at a reactor pressure of 200-300 psi and a reactor-inlet temperature of 900-950 F. Hydrogen recycle rate and space velocity are adjusted to the particular characteristics of the charge and to the product desired.

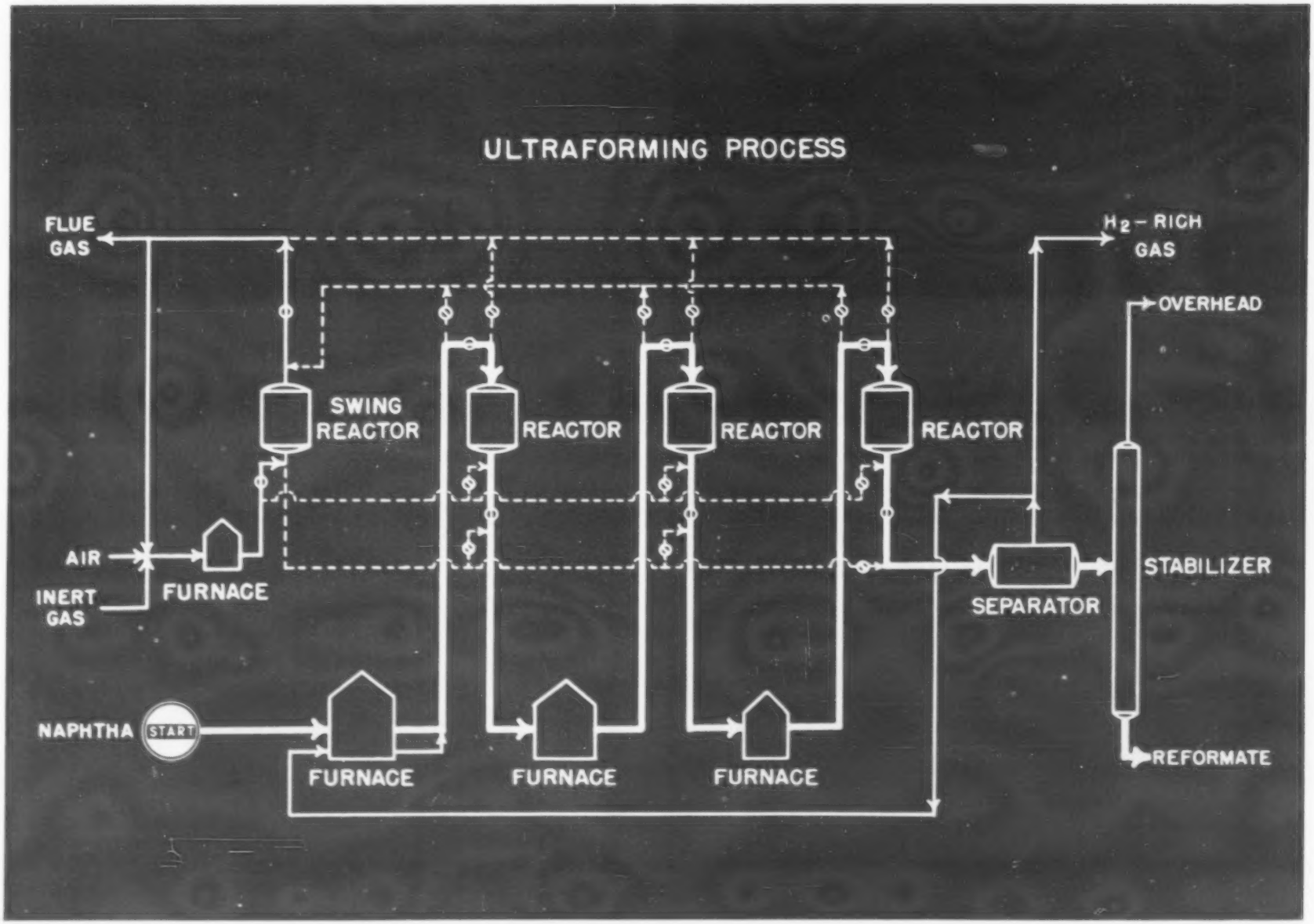
Yields—Ultraforming yields from Gulf Coast, Mid-Continent and Kuwait naphtha are shown in the accompanying table.

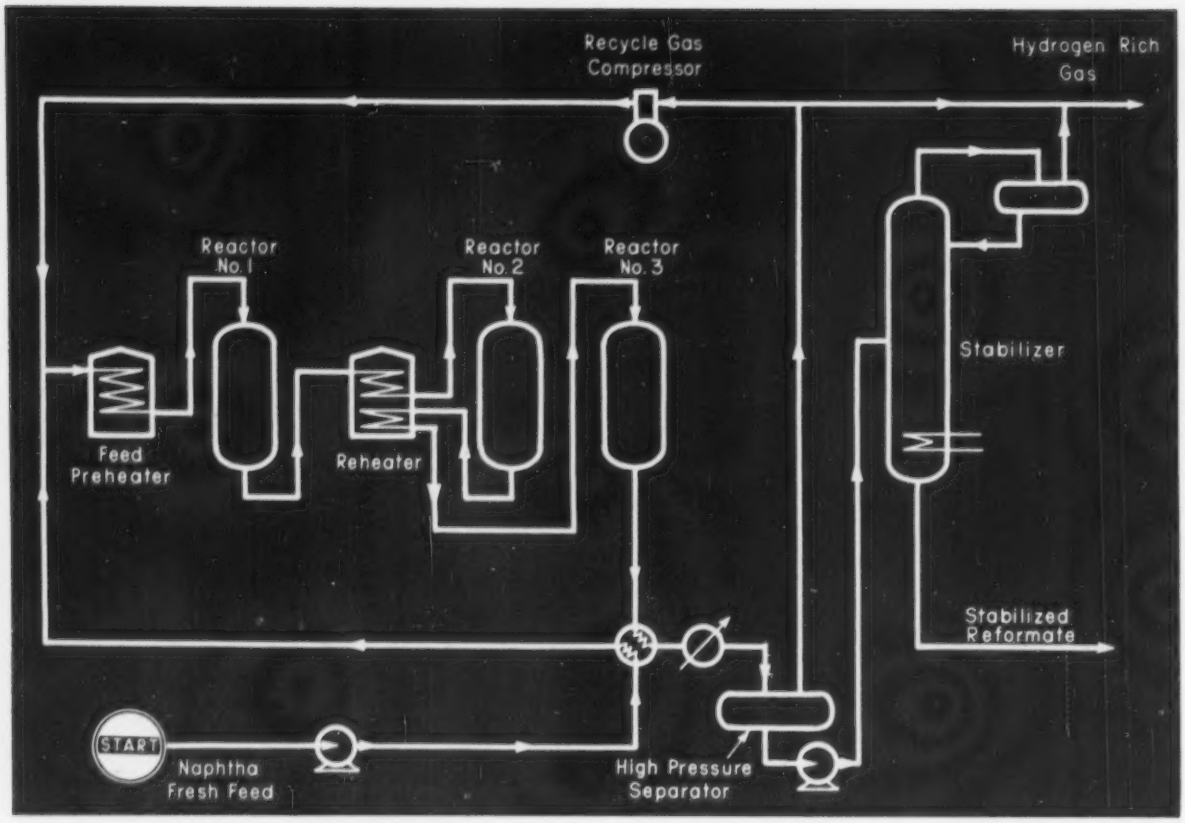
Commercial Installations—A total of 25 commercial Ultraforming units are operating, building or under design. These include units of Standard, its affiliates and licensees. The combined capacity of these units is 237,000 bpd. A total of 13 Ultraforming units are already in operation.

ULTRAFORMING YIELDS

Charge Naphtha—	Gulf Coast		Mid-Continent		Kuwait	
A.S.T.M. Dist., F.:						
Initial	189		193		193	
10 percent	212		239		220	
50 percent	254		280		266	
90 percent	324		328		330	
End point	360		360		366	
Composition, Volume Percent:						
Paraffins	28		48		70	
Naphthenes	63		44		19	
Aromatics	9		8		11	
Octane No., Research:						
Clear	66		45		35	
Products—						
C5 + Reformate:						
Octane No., research, clear	90	100	90	100	90	95
Yield, volume percent	90.5	80.7	85.6	76.4	79.5	74.6
R.v.p.	2.4	3.2	3.2	4.7	4.6	5.0
Butanes, volume percent	1.7	5.8	4.3	8.4	8.7	11.3
Dry gas, weight percent	4.3	9.6	7.0	11.8	10.2	13.0
Hydrogen, s.c.f./bbl.	1,200	1,460	1,010	1,110	675	710
10-Lb. Gasoline:						
Octane No., research, clear	90	100	90	100	90	95
Yield, volume percent	106.5	93.6	100.8	83.2	87.8	81.6

Reference—PETROLEUM REFINER, vol 35, no 5, p 171 (May, 1956).


ULTRAFORMING PROCESS
FLUE GAS
H_2 – RICH GAS
OVERHEAD
SWING REACTOR
REACTOR
REACTOR
REACTOR
AIR
INERT GAS
FURNACE
SEPARATOR
STABILIZER
NAPHTHA
START
FURNACE
FURNACE
FURNACE
REFORMATE



Houdriforming—HOUDRY PROCESS CORPORATION

Application—Houdriforming is a continuous catalytic process using a platinum-containing catalyst to reform straight run and cracked naphthas.

Charge—The process will charge a wide variety of feed stocks, differing substantially in chemical composition and boiling points up to 400 F.

Products—Houdriforming will produce aromatics, aviation blending stocks, and motor gasoline in the 80-100 F-1 clear octane range, dependent upon composition of feed and type or severity of operation.

Description—The Houdry Type 3 platinum-content catalyst used in Houdriforming meets exacting specifications for activity, selectivity and strength. It is well balanced to carry out the dehydrogenation, aromatization, isomerization, hydrocracking and desulfurization reactions involved.

Pre-treatment of high-sulfur stocks is provided by means of a catalytic "guard case" chamber with its own pre-heater, constructed as an integral stage of the Houdriforming operation.

At moderate severities, Houdriforming may be operated for either high-octane motor gasoline or aromatics in a truly continuous manner, without provision for catalyst regeneration. The operation also provides refineries with hydrogen of exceptionally high purity.

Should high severity operation be required, Houdriforming lends itself readily to in-place regeneration, as has been demonstrated commercially. Most units, however, are operated under moderate conditions providing greatest economy and efficiency.

Operating Conditions—Temperature 875-950 F.; Pressure 250-600 psig; Space velocity 1.5-5.0 v/hr/v; Hydrogen-oil mole ratio 4-10.

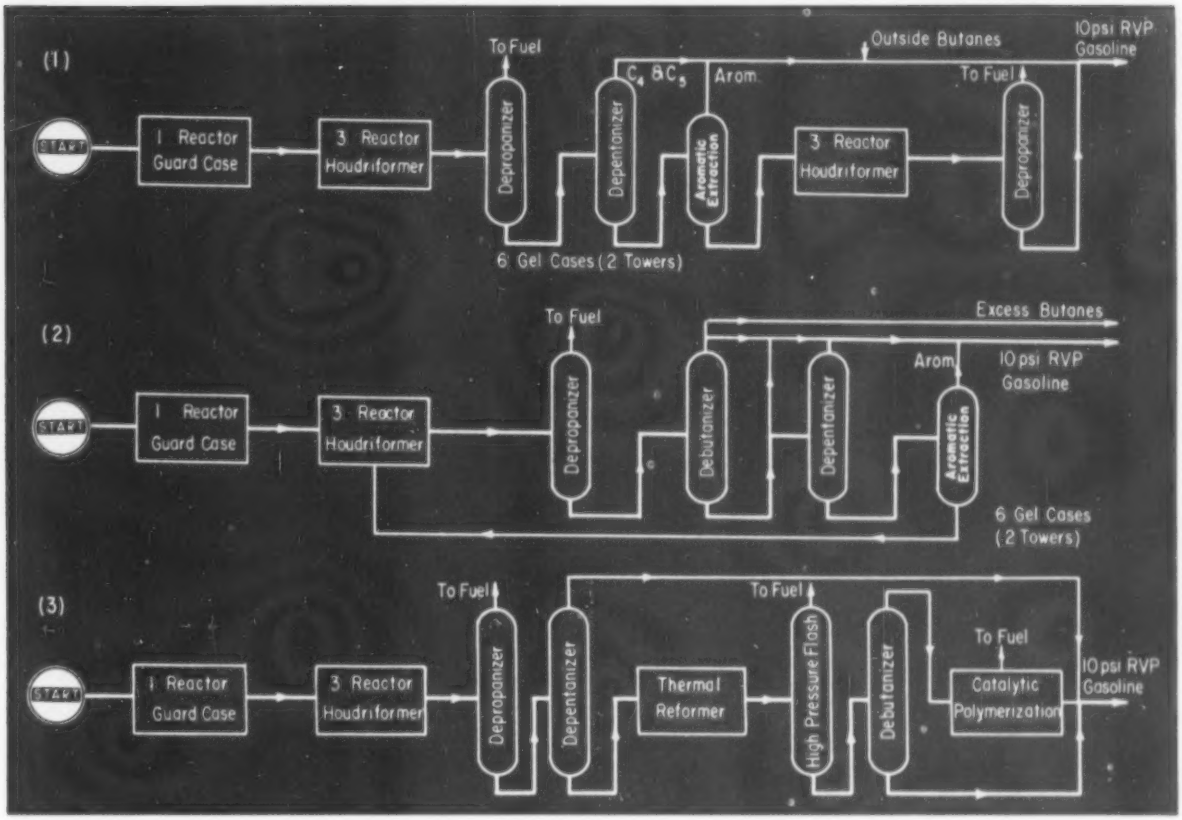
MOTOR GASOLINE PRODUCTS

Charge Stock—	Low Paraffin Content Naphtha From Mixed Naphthenic Crudes		Intermediate Paraffin Content Naphtha From East Texas Crude		High Paraffin Content Naphtha From Kuwait Crude	
Gravity, °API	45.8		55.3		52.9	
F-1 Clear Octane	61.3		55.6		23.5	
Sulfur, Weight Percent	0.012		0.006		0.10	
	OPERATION					
Houdriforming Data:	Mild	Severe	Mild	Severe	Mild	Severe
Yields, based on Charge:						
Debutanized Reformate, Vol. Percent	88.3	80.6	91.0	83.5	87.4	80.4
Debut. Reformate:						
F-1 Clear Octane	92.0	*101.0	80.0	92.0	76.8	90.0
F-1 +3 cc. TEL	99.2	*104.2	92.5	99.5	91.0	98.3
Gravity, °API	39.7	36.5	52.7	45.8	50.7	47.7
Sulfur, Weight Percent	0.002	0.002	<0.001	0.002	<0.001	<0.001

* Octanes above 100 are extrapolated by method of Deters, J. F., Pet. Ref., Vol. 30 No. 6 (June 1951).

Commercial Installations—Total licensed Houdriforming capacity amounts to 143,040 bpsd. Thirteen Houdriforming units now on stream have a nominal design capacity of 70,310 bpsd; six additional Houdriformers under construction or in the engineering stage have a total design capacity of 72,730 bpsd. The largest of the latter is 45,000 bpsd unit.

Reference—PETROLEUM REFINER, vol 32, No 5, p 113 (May, 1953).



Iso-Plus Houdriforming—HOUDRY PROCESS CORPORATION

Application—Iso-Plus Houdriforming provides refiners with a method of coupling either aromatics separation or thermal reforming with conventional catalytic Houdriforming to derive high yields of 100 octane (and higher) F-1 clear gasoline from low-octane naphthas.

Charge—Same as Houdriforming.

Product—Iso-Plus aromatics extraction variations in experimental runs have yielded up to 90 percent of naphtha charge as 100-octane gasoline F-1 clear. One of the aromatics alternatives, with slight operational modifications, yields 82 volume percent of charge as 108-octane gasoline F-1 clear.

Description—Operating conditions for Houdriforming are moderate in all three Iso-Plus variations, and pretreating by the integrated Houdry "guard case" catalytic reactor permits charging of stocks of relatively high sulfur content.

In one Iso-Plus variation employing aromatics separation (see literature reference), an 87 F-1 clear Houdriformate is flashed, and then stabilized, with butanes and pentanes going to product. Dependanized effluent is charged to extraction, with a 90 percent aromatic concentrate separated as product. An 81 percent paraffinic raffinate is moved to a second Houdriforming stage, yielding 81 F-1 clear Houldiformate for flashing and depropanizing.

The final blend of 100-octane F-1 clear gasoline in this case consists of the aromatic concentrate, butanes and pentanes from the first Houdriforming stage, and the stabilized Houdriformate from the second pass.

Recycling the second-pass Houdriformate to aromatics extraction, thereby ultimately converting paraffins to 90 percent aromatic concentrate, pentanes and lighter, makes it possible in this scheme to recover more than 80 percent of naphtha charge as 108 F-1 clear octane 10-lb. RVP gasoline.

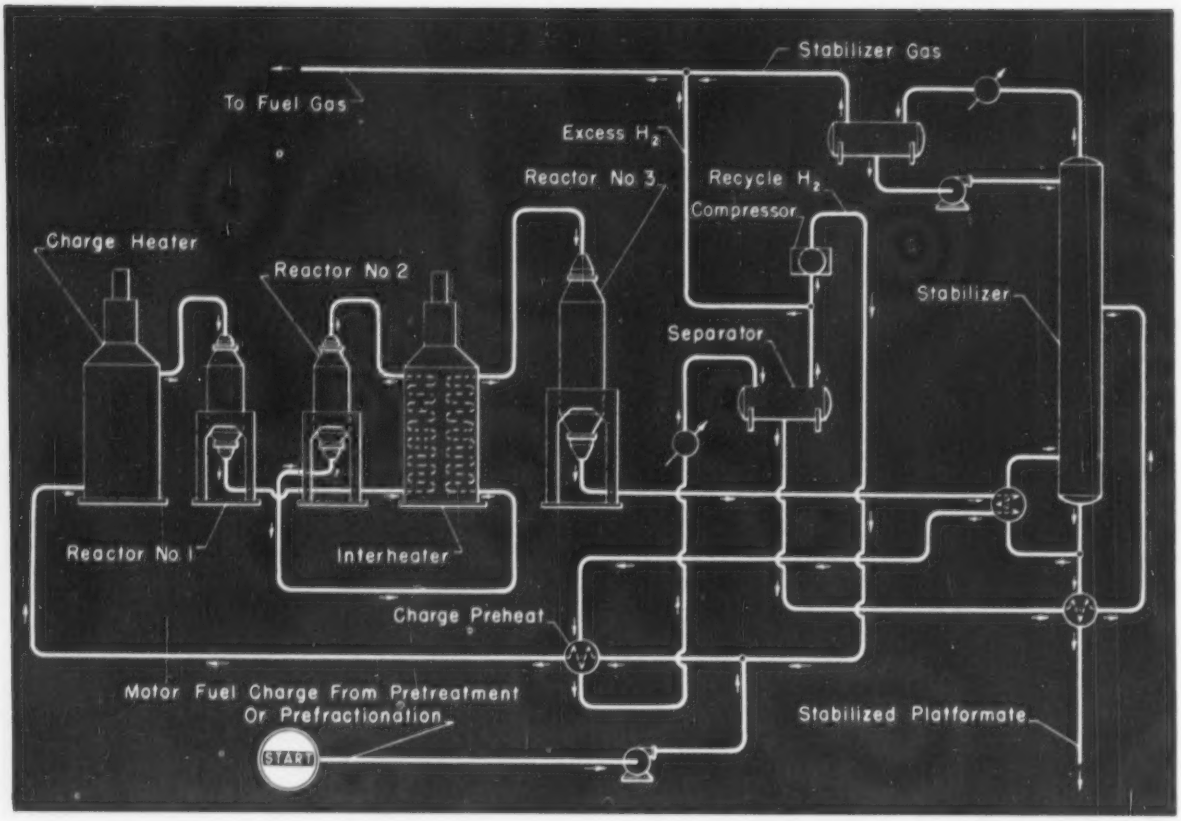
The second Iso-Plus aromatics separation route employs only one Houdriforming stage. Dependanized effluent is an 83 F-1 clear Houdriformate, with most butanes and part of the debutanized reformate going to final product. The remainder of the Houdriformate undergoes extraction, with concentrate going to product and raffinate recycling to the main feed stream to the Houdriformer. See literature reference.

The Iso-Plus Houdriforming thermal variation pretreats, strips and reforms the charge to an 87 F-1 clear Houdriformate. After depropanizing and dependanizing, with propanes going to refinery fuel and butanes and pentanes going to blending, the dependanized effluent is thermally reformed, flashed and debutanized. The C_3-C_4 cut goes to catalytic polymerization. The resulting polymer gasoline goes to blending with debutanized reformate, butanes and pentanes.

Yields—Refinery and pilot plant Iso-Plus Houdriforming coupled with thermal reforming have yielded from 80 to 90 percent of reformed gasoline, depending upon the octane rating desired for final product. This Iso-Plus route appears to be particularly attractive to refineries with available thermal reforming units.

Commercial Installations—One Iso-Plus Houdriforming unit recently completed in Italy has a nominal design capacity of 4000 bpsd, with regular Houdriformate being part of the product and 1700 bpsd separated as charge to a thermal unit of that capacity. A second Iso-Plus Houdriforming process unit nearing completion in the U. S. has a nominal design capacity of 45,000 bpsd. This installation will employ aromatics extraction as the supplemental process.

Reference—PETROLEUM REFINER, vol 34, no 9, p 135 (Sept, 1955).



Platforming—UNIVERSAL OIL PRODUCTS COMPANY

Application—Platforming has three principal applications: (1) to upgrade low-octane naphthas to premium quality motor fuels, (2) to produce high yields of aromatic hydrocarbons from select naphtha cuts, and (3) to produce high-quality aviation gasoline components.

Charge—For motor fuel operation; straight run and/or cracked naphthas boiling in the range of 150-400 F. For aromatics or avgas operations; selected straight run naphtha fractions.

Products—Motor fuel operation: Typical product is stable, requires no rerunning, and can be produced at any desired quality to fit marketing requirements.

Aromatics operation: Product contains benzene, toluene, xylenes, and other aromatics. The charge stock, boiling range and unit operating conditions are adjusted to maximize production of the desired individual aromatics. Separation of aromatics from the Platformate is accomplished by Udex solvent extraction, followed by the recovery of individual aromatics in extremely high purity by distillation.

Description—The accompanying flow diagram depicts a typical Platforming unit. The unit may generally be divided into three sections: the reactor-heater section in which the charge plus recycle gas is heated and passed over the catalyst; the separation and compression in which the reactor effluent is separated into gas and liquid streams, the gas being compressed for recycling; and the stabilization section in which the separator liquid is stabilized to the desired vapor pressure.

Depending upon the character of the feed stock, it may be desirable to add a recycle gas scrubbing system to remove H_2S from the gas. The Unifining process has proved valuable as a means of producing satisfactory feed stocks from otherwise unsuitable materials.

The principal chemical reactions involved are dehydrogenation of naphthenes to aromatics, dehydrocyclization of paraffins, hydrocracking of high molecular-weight paraffins to lower molecular-weight paraffins, isomerization of paraffins and of naphthenes, and desulfurization of sulfur compounds, forming hydrogen sulfide.

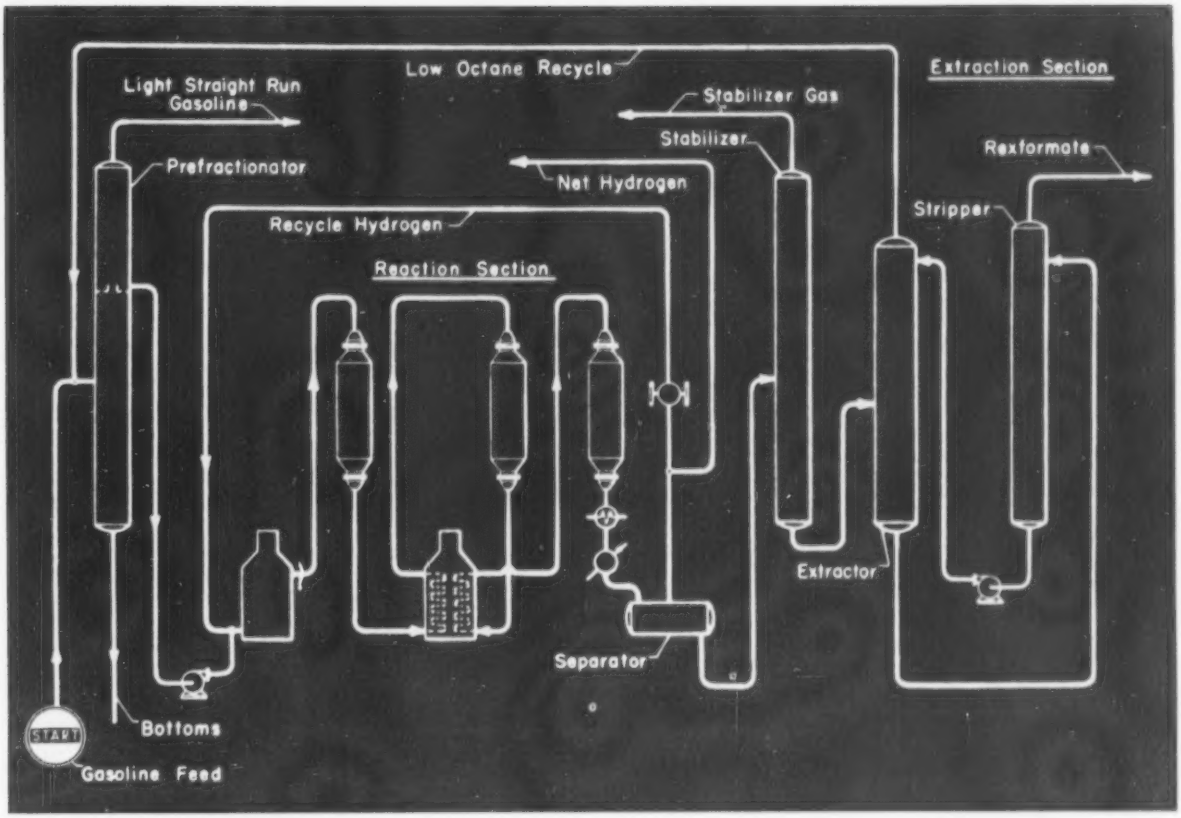
Operating Conditions—The four major process variables are temperature, space velocity, pressure and hydrogen recycle rate. The reactor temperature is normally in the range of 850-980 F. when operating at pressures from 200-800 psig.

Yields—Platformates produced from a Mid-Continent naphtha under three different operating conditions are shown in the following table.

	Charge Stock	PLATFORMATES		
		1	2	3
Yield of 10 lb. RVP Plat., L. V. Percent of Charge		101.0	96.8	89.3
Extraneous C_4 Req. to 10 lb. RVP, L.V. Percent of Charge		8.2	6.2	1.8
RVP	0.2	10.0	10.0	10.0
Octane Ratings:				
F-1 Clear	32.4	85.0	90.0	95.0
+3cc TEL/Gallon	56.4	95.5	98.5	100+0.12
Percent Sulfur	0.04			
Molecular Weight	128			
UOP "K"	11.93			
Debutanized Gasoline:				
°API	52.6	48.0	46.8	44.8
100 Ml. Dist.:				
IBP, F	230	144	140	132
10 Percent	255	200	191	173
50 Percent	308	285	281	272
90 Percent	372	366	366	365
95 Percent	382	384	386	389
End Point	397	410	412	413

Commercial Installations—Platforming is the pioneer catalytic reforming process employing a platinum-containing catalyst. Units from 200 to 29,000 barrels per stream day are in commercial operation.

Reference—PETROLEUM REFINER, vol 31, no 5, p 97 (May, 1952.)



Rexforming—UNIVERSAL OIL PRODUCTS COMPANY

Application—The UOP Rexforming process economically produces a product having an unleaded Research octane rating ranging upwards from 98-100 when charging a normal, full boiling range gasoline.

Product—The Rexformate product consists of 58 percent or more aromatics, approximately 5 percent naphthenes, olefins in trace amounts and the balance is high-octane relatively low-boiling paraffins.

Description—Rexforming is a combination process, as indicated in the flowsheet, employing elements of the UOP Platforming method of catalytic reforming in conjunction with some steps of the Udex procedure for recovering aromatics.

When charging a full boiling range gasoline, a prefractionator is used to prepare a 180 or 200 degrees IBP to 400 degrees EP heart cut as a side-stream which constitutes feed to the catalytic section. This section employs the Platforming catalyst and flow through it is similar to that in the catalytic section of a Platforming unit. The reactor effluent is flashed to recover hydrogen produced in the process as net make and for recycling. The remaining liquid is stabilized to desired vapor pressure and initial boiling point.

The stabilized reactor effluent then is contacted in a specially designed extractor column with an aqueous solution of glycol in counter-current flow. The overhead, or raffinate, product from this column contains essentially all of the high-boiling, low-octane paraffins. This stream is recycled to the reactor section via the prefractionator feed, whence it appears in the heart cut previously mentioned. The bottom, or extract, product is stripped of dissolved hydrocarbons in the last column. The stripper overhead is Rexformate. The bottom product is solvent of the desired composition to effect the recovery of Rexformate and is recycled to the extractor.

Severe catalytic reforming conditions are unnecessary to secure a "super fuel" from the octane standpoint. This makes for long catalyst life and high yields and reduces equipment maintenance costs in comparison with once-through catalytic reforming to the same octane level.

The extractor column conditions are set to control the quality of the Rexformate, rather than the reactor conditions as in Platforming. Reactor conditions are set for the optimum conversion of hydrocarbons in the total reactor feed into high octane compounds.

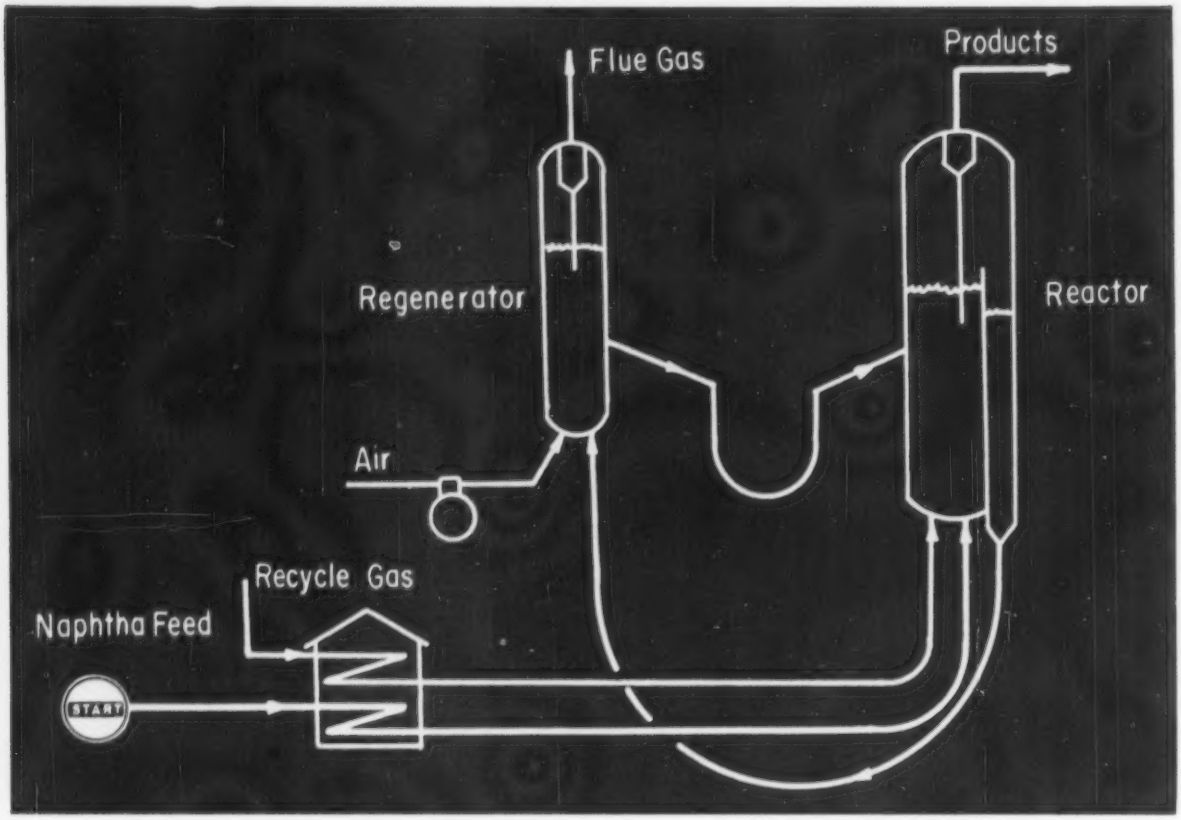
Since the raffinate is a recycle stream rather than a final product in Rexforming, there are no "losses" of high octane materials to a low-quality stream. This permits important equipment simplification and operating economies because the separation between raffinate and extract need not be extremely sharp.

Yields—The superlative quality of Rexformate is indicated in the accompanying data tabulation:

	Reactor Combined Feed	Debutanized Rexformate
Gravity, °API	56–58	42
ASTM Distillation:		
Initial Boiling Point, F	180	110
10 Percent	215	160
30 Percent	240	210
50 Percent	**260**	**240**
70 Percent	287	275
90 Percent	334	330
End Point	380	410
Sulfur, Weight Percent	0.055	0.001
Hydrocarbon Type, Volume Percent:		
Paraffin	60.5	35
Olefin	Trace	0
Naphthene	33.5	5
Aromatic	6.0	60
Reid Vapor Pressure		3.6
Octane Rating:		
Research, Clear		98.0 (min.)
+ 3 ml. TEL		iso C_8 + 0.19 ml. TEL
Yield, Volume Percent Fresh Feed, Estimated		81.0

Commercial Installations—Two Rexforming units already have been placed on stream and demonstrated its capability to produce high quality product. Another is scheduled to be operating before the end of 1956. A number of Platforming units also contain provisions for future conversion to Rexforming.

Reference—Petroleum Refiner, vol 34, no 4, p 116 (Apr, 1955).



Fluid Hydroforming—ESSO RESEARCH AND ENGINEERING COMPANY

Application—Fluid Hydroforming is a flexible, fully-continuous process using the fluidized solids technique (and a molybdena-alumina catalyst) to convert virgin and cracked naphthas to high-octane gasoline.

Charge—A great variety of feed stocks has been reformed to products in the 90 to 100-octane number range. Middle East naphtha has been Hydroformed commercially to over 100 research octane clear. Both narrow- and wide-cut feeds have been processed. There is no limitation on feed end point, and feeds containing cracked stocks can be reformed with excellent yields without pretreatment for olefin saturation or sulfur removal. Yields from fluid Hydroforming at any octane level depend on the feed-stock quality.

Product—Principal product is a high-octane naphtha which can be used in motor gasoline directly or extracted for aromatic blending stocks for aviation gasoline. The liquid products are essentially sulfur-free. The tail gas produced in Fluid Hydroforming can be used for hydrofinishing other refinery stocks for sulfur removal.

Description—The finely-divided catalyst, behaving much like a fluid, circulates continuously between the reactor and the regenerator. The catalyst is cheap and rugged, and not susceptible to poisoning by sulfur or water. The feed stock does not require pretreating for sulfur removal. Selectivity of the catalyst does not fall off with continued use.

The preheated naphtha feed enters the bottom of the reactor where it meets a hot isothermal bed of catalyst. The reformed products leave the catalyst bed and pass through separators where entrained catalyst is removed and returned to the bed. The overhead products are heat exchanged, cooled and separated into gaseous and liquid products.

After stabilization, the liquid product is removed as high-octane gasoline. A portion of the gaseous product is compressed, heated, and recycled to the reactor to supply additional heat.

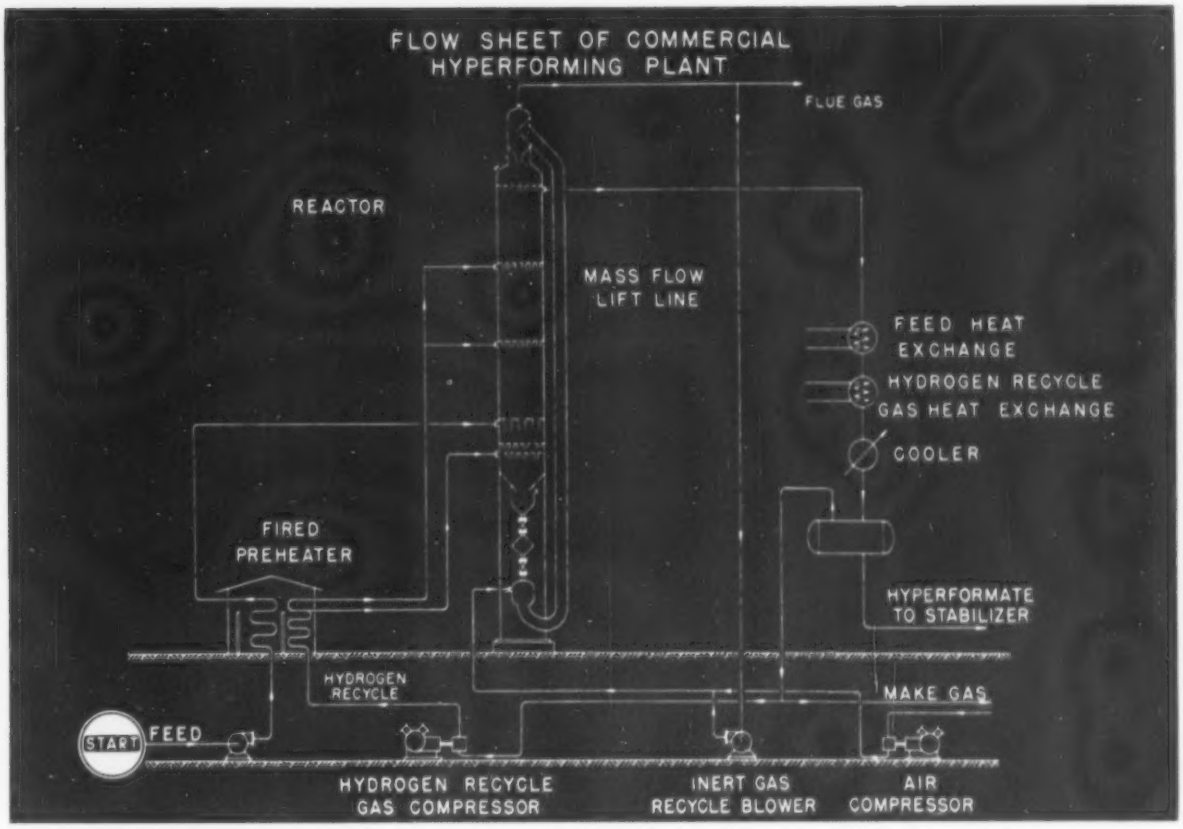
To remove carbon which deposits on the catalyst during the reaction, a portion is continuously withdrawn and allowed to flow to the regenerator. Here carbon is burned off with air which liberates large quantities of heat. The heat may be used to produce steam or preheat the feed. The hot regenerated catalyst returns as a fluidized stream to the reactor, supplying some of the heat required and completing the continuous cycle.

Commercial Installations—The first Fluid Hydroformer went on stream in 1953. Eight others have started up since then, with a tenth unit scheduled to go on stream during the third-quarter of 1956. Total capacity of the ten units is listed at 114,230 barrels per stream day. The accompanying table lists the ten Fluid Hydroforming units.

Reference—PETROLEUM REFINER, vol 34, no 11, p 214 (Nov, 1955).

Fluid Hydroforming Units
In Operation or Under Construction

COMPANY	Location	Capacity B/SD	Date on Stream	Builder
Pan-Am. Southern Corp.	Destrehan, La.	2,000	1953	M.W. Kellogg
Toa Nenryo Kogya Co., Ltd. (Standard-Vacuum Oil Co.)	Wakayama, Japan	4,700	Dec., 1954	Toa Nenryo
Cities Service Oil Co.	East Chicago, Ind.	12,780	Jan., 1955	M.W. Kellogg
Cities Service Refining Co.	Lake Charles, La.	17,250	Feb., 1955	M.W. Kellogg
Esso Standard Oil Co.	Baton Rouge, La.	22,200	March, 1955	C.F. Braun
Creole Petroleum Corp.	Amuay, Venezuela	11,100	March, 1955	Foster Wheeler
Arabian American Oil Co.	Ras Tanura, S.A.	12,500	July, 1955	Lummus
Stanic	Leghorn, Italy	8,900	Nov., 1955	CTIP
Esso Petroleum Co.	Fawley, England	15,000	April, 1956	Foster Wheeler
Esso A.G.	Hamburg, Germany	7,800	July, 1956	Lurgi
Total		114,230		



Hyperforming—UNION OIL COMPANY OF CALIFORNIA

Application—Hyperforming is applicable to the upgrading of straight-run gasolines and blends of straight-run and cracked gasolines to produce products which are gum stable, essentially free from nitrogen and sulfur, elevated in octane number and reduced in average boiling range. Incorporation of catalyst regeneration facilities allows flexibility with respect to fluctuations in feedstock quality.

Description—The Hyperforming process is a continuous, regenerative, catalytic reforming process which utilizes the new Hyperflow catalyst-handling technique. The catalyst is circulated at very low velocities by this new Hyperflow lift principle.

The reactor utilizes a moving bed of a special cobalt molybdate type catalyst, and a recycle stream of hydrogen is employed to carry out the catalytic reactions. The reactor incorporates solids-handling features which provide positive control of catalyst motion. The catalyst moves downward through the reactor under gravity flow, and is returned back into the top of the reactor by means of mass conveyance in a catalyst-transfer line. Simultaneously with this vertical lift of the catalyst, its regeneration is effected in the lift line. In high capacity units requiring high severities, a separate vessel may be utilized for carrying out catalyst regeneration.

The naphtha charge stock to be processed is heat-exchanged with the reactor effluent and then introduced into the bottom of the reactor. The vaporized naphtha charge, mixed with the recycle gas, flows upward countercurrent to the descending catalyst. Additional hot hydrogen is introduced into the reactor at several interheating points. The processed naphtha leaves the top of the reactor and passes through the preheat exchanger for cooling. Separation of recycle gas and liquid product is then effected.

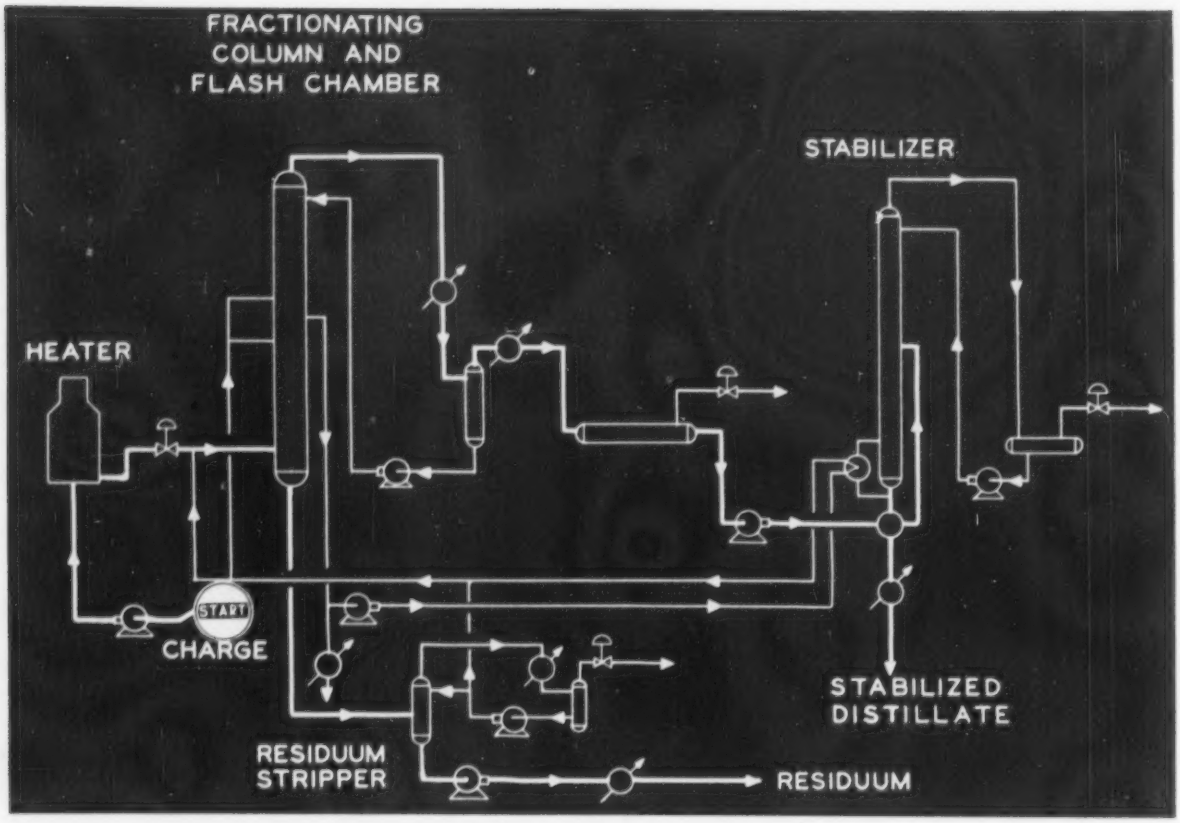
A blend of straight-run gasoline and cracked stock can be processed by Hyperforming. In the course of the upgrading, the hydrogen released in the dehydrogenation of naphthenes is used for the elimination of any sulfur, nitrogen, and oxygen compounds which may be present. Olefins are saturated as well without outside hydrogen addition.

Other reactions occuring during Hyperforming are the dehydrogenation of naphthenes to aromatics while dehydrocyclization of paraffins is a feature leading to high quality products from paraffinic feedstocks. A substantial amount of hydrocracking of the higher molecular weight hydrocarbons occurs together with isomerization of paraffins and naphthenes.

Operating Conditions—Hyperforming is carried out at pressure levels in the order of 400 psi and reactor temperatures are in the range of 900 F. Hydrogen recycle is utilized and liquid hourly space velocity is adjusted to the particular characteristics of the stock being processed.

Commercial Operation—The first commercial Hyperforming demonstration unit is installed at the Signal Hill plant of the Calstate Refining Company. The plant processes primarily straight-run gasoline from Los Angeles Basin crude oil plus a small amount of visbreaker pressure distillate. Simultaneous octane improvement to the 96 leaded research level and desulfurization are effected. The product is sweet and contains 0.003 percent sulfur, as compared with 0.2-0.3 percent sulfur in the feed charge. Upon completion of current operating studies and equipment evaluation the process may be made available for larger scale applications.

Reference—Petroleum Refiner, vol 33, no 10, p 153 (Oct. 1954).



Thermal Reforming—UNIVERSAL OIL PRODUCTS COMPANY

Application—The process converts low-grade gasolines and naphthas into high-octane gasoline. It also produces butane-butylenes and propane-propylene which can be polymerized to produce a high-octane polymer gasoline. The residuum from Thermal Reforming has a high calorific value, and can be marketed as fuel oil.

Description—A straight-run gasoline or naphtha fraction is charged to a heater wherein the reaction time, pressure, and discharge temperature are controlled to produce the desired products. The effluent from the heater passes through a pressure control valve where the pressure is reduced. A quench stream from the fractionator is introduced after the control valve to reduce the temperature of the effluent and minimize coking.

The quenched products enter a combination flash chamber and fractionating column wherein the gas and gasoline are taken overhead, and the small amount of bottoms produced is removed from the lower portion of the vessel. A cracked naphtha side-cut from this column is used for quench and heat exchange duty. Naphtha side-cuts may be withdrawn if desired.

The overhead products from the fractionator are cooled, and the condensed, unstabilized gasoline is sent to a stabilizer to produce the desired vapor pressure. If polymerization of the gases evolved from the cracking operation is desired, an absorber for the receiver gases plus deep stabilization of the gasoline is employed to provide maximum recovery and utilization of polymerizable olefins available.

The bottoms withdrawn from the flash chamber portion of the reformer column are further flashed in a residuum stripper. Light overhead material removed from the residuum at this point is condensed and returned to the fractionating column, whereas the residuum is sent to storage for subsequent disposal as fuel oil. The properties of the residuum are regulated by suitable control of reflux to the stripper.

Yields—A typical result when reforming a 53° API Mid-Continent straight-run naphtha is shown below.

Charging Stock:	
Gravity, °API	53.0
Octane Rating, ASTM (F-2) Clear	40.5
Characterization Factor	11.96
100 Ml. Distillation:	
Initial Boiling Point, F	208
10 Percent	263
50 Percent	314
90 Percent	367
End Point, F	389
Products:	
Gasoline:	
Yield, Volume Percent of Charge	81.3
Gravity, °API	56.1
Reid Vapor Pressure, Lb.	10.0
100 Ml. Distillation:	
Initial Boiling Point, F	93
10 Percent	145
50 Percent	270
90 Percent	360
End Point, F	398
Octane Ratings:	
ASTM (F-2), Clear	70.2
+ 3 cc. TEL/Gallon	81.9
Research (F-1), Clear	78.2
+ 3 cc. TEL/Gallon	91.3
Residuum:	
Yield, Volume Percent of Charge	4.2
Gravity, °API	18.2
Gas:	
Yield, Weight Percent of Charge	15.3
Cu. Ft./Barrel of Charge	467

Cracking

CRACKING, the process developed to produce more gasoline from a barrel of crude, now supplies approximately 45 percent of the total gasoline pool, more than any other process technique. Originally started as thermal cracking, this process has progressed so far into the catalytic phase that no new thermal cracking units are now being installed in the U. S. (although the thermal type continues to supply about 15 percent of the gasoline pool).

Cracking is a phenomenon by which large molecules are decomposed into smaller (and lower boiling) molecules. At the same time some of these molecules combine with one another to give even larger molecules than those in the original charge stock. The more stable molecules leave the system as cracked gasoline, while the reactive ones polymerize, forming cracked fuel oil and coke.

Development of catalytic cracking has been the most dramatic achievement of the refining industry both in capacity (42 percent on crude capacity) and in technological advance (perfection of gas-solids technique).

Catalytic cracking, in contrast to thermal cracking, gives rise to more selective cracking and less light-ends products. In addition, the catalyst is more effective in causing cyclization and some isomerization to produce aromatics, naphthenes and isoparaffins, rather than the predominating dehydrogenation to form olefins that occurs in thermal cracking operation. Use of a catalyst, usually a natural or synthetic aluminosilicate, also results in higher yields of high-octane gasoline without the concurrent production of low-value heavy fuel oil which is always a product of thermal cracking. Higher investment and operating costs of the catalytic process thus are balanced by increased product quality.

In operation, the major process variables are temperature, catalyst/oil ratio and space velocity. Regulation of these variables, along with the extent of internal recycling, makes the cracking process extremely flexible with respect to product distribution and quality requirements. In practice, recycle varies from 0 to 60 percent of total feed. Now averaging about 24 percent, the trend is towards higher recycle ratios.

Most recent trend in catalytic cracking is the use of two reaction stages in the Shell Two-Stage Fluid Catalytic Cracking Process, p 234 (PETROLEUM REFINER May, p. 166). This process was developed to combine the advantages of short-contact-time cracking and of multiple staging.

Feed stocks may range from naphtha cuts to reduced crudes, but the most commonly employed feed is a gas oil with an initial boiling point higher than the end point of the gasoline to be produced. Thus for aviation gasoline production, the IBP of the feed stock will be 300 F.; and for motor gasoline, above 400 F.

Residual stocks have not been processed in many cases due to excessive coke formation and metal contamination of catalyst. However, advances in operation (such as the Houdresid Process, p 238) have proven successful with feeds low in metal contaminants.

Usually, feed preparation techniques must be employed to remove salts and asphalts before catalytic cracking operations with heavy stocks. Feed preparation for catalytic cracking may be carried out in one of these ways: Coking, propane deasphalting, furfural extraction, vacuum distillation, viscosity breaking, thermal cracking or hydrodesulfurization. Aim of these processes is to decrease production of residual fuels and make more feed stock available for cracking.

Coking is actually a cracking process which extends the time of cracking so that coke is formed instead of minimized as in thermal and catalytic cracking. Although design-wise it is very similar to thermal cracking, it has its own set of economic conditions. When market demand and price of residual fuels are low in relation to gasoline, the coking process (which yields gas oil, gasoline, gas and solid coke as products) becomes attractive. This has been the case in recent years but the search for more catalytic cracking feed stocks also has given impetus to the coking boom (now 340,000 bpd in capacity).

Using residual stocks or reduced crude for charge, coking units produce a clean gas oil charge for catalytic cracking. Coking processes are of three types—batch, delayed and fluid. The batch process, rapidly becoming extinct, deposits coke in a shell still which must be shut down periodically to remove the accumulated coke. The delayed process, which is semi-continuous, deposits coke in a drum immediately after the reaction heater. The drum is taken off stream periodically to remove the coke.

Fluid coking, which promises to capture most of the new capacity, uses coke particles as seeds in the formation of coke. These coke particles are removed continuously from a fluidized bed. Major advantages claimed for this fluid process are its continuous nature, made possible by the coke circulation system which requires minimum physical handling, and the fact that the process normally requires no external furnace.

Visbreaking is a variation in thermal cracking in which the charge stock is residual fuel oil or reduced crude and is cracked under such mild conditions (short-time decomposition and mild temperatures) that coke formation is minimized. Thus the viscosity of the fuel oil is reduced and a clean gas oil is produced for further cracking. Coking is now the more popular process for handling such stocks but visbreaking capacity stands at 670,000 bpd.

These thermal schemes used for cracking of individual charge stocks are often assembled into "combination" units (p 244) which accomplish the complete processing of a crude oil. The combination of several process steps into a single unit offers good opportunity for saving in operating equipment and utilities, e.g., heaters and exchangers.

References: Sittig, "Catalytic Cracking Techniques in Review," PETROLEUM REFINER, September, 1952, pages 263-316.

"Thermal Conversion Processes," PETROLEUM REFINER, September, 1949, pages 130-159.

Airlift TCC—SOCONY MOBIL OIL COMPANY, INC.

Application—The Thermofor Catalytic Cracking process is used primarily to (1) produce high quality gasoline, (2) increase the yield of distillate fuel fractions, and (3) reduce the yield of residual fuels. By-products of TCC operations are large yields of valuable feed stocks for alkylation and catalytic polymerization units.

Charge—In commercial practice a wide variety of feed stocks are charged to these units. Full range gas oils either virgin or previously processed are concurrently employed and in some cases whole crude may be charged. The feed is sometimes supplemented with straight-run naphtha in order to realize an octane number improvement and a degree of desulfurization.

Products—The flexibility of the process and the available range of operating conditions permit variations of product distribution. Thus, gasoline, octane rating, or burning fuels may be maximized to fit the economics of the particular refinery. The high ratio of isobutane to butenes is advantageous where secondary processing includes alkylation.

Description—The first commercial TCC unit was placed on stream in 1943. In 1950 the first Airlift TCC was started up, in which the original design was modified by superimposing the reactor over the kiln and replacing the bucket elevators with a catalyst airlift. These changes resulted in reduced investment costs, simplified operation and improved flexibility. Continuing progress in design improvements have given existing units increases of up to 50 percent in reactor and kiln capacity at little modification expense. Referring to the accompanying flow diagram, the charge is first heat exchanged against fractionator streams, combined with recycle (if any), heated and charged to the reactor as a mixture of vapor and liquid. Alternate feed preparation systems may employ a tar separator and a vacuum jug, or some prior processing step such as visbreaking, coking or propane deasphalting.

In the catalytic section regenerated catalyst slowly flows by gravity down the seal leg from the surge hopper to the reactor. Sealing steam or flue gas flows countercurrently upwards, thereby permitting the pressure to increase from atmospheric in the surge hopper to as much as 15 psig in the reactor. In the reactor, catalyst flows slowly through a reaction bed of uniform depth, past vapor collecting grids, through a purge zone, and out of the reactor. The purged spent catalyst from the bottom of the reactor gravitates into the top of the kiln and then through the kiln where it first contacts flue gas of low oxygen content in the upper (countercurrent flow) section. As the catalyst passes downward in the kiln, its temperature is raised by the combustion of the coke, and then reduced by the incoming air. In the lower section of the kiln the air and catalyst flow concurrently downward, the flue gas is disengaged and the catalyst passes to the coolers. These coolers remove excess heat of coke combustion by generating steam and are controlled to cool the catalyst to the desired temperature for return to the reactor section. The regenerated catalyst flows from the coolers into the lift pot where it is picked up by low-pressure air (introduced at 2 to 3 psig) and lifted to the surge hopper at the top of the unit. The catalyst is separated from the lift air in the surge hopper and flows slowly down the seal leg to complete the cycle.

The effluent vapors from the reactor flow to simple fractionating and gas recovery systems to separate the cuts desired for blending into final refinery products. The TCC reactor effluent contains essentially no inert gases that would increase recovery problems.

While there are many catalysts that may be used in these units, a synthetic bead catalyst is generally preferred, since the excellent properties of this material help to maintain low unit operating expense. The bead catalyst is unusually stable and maintains a high level of equilibrium activity. The structure of the bead resists attrition. Catalyst consumption rates for all the units on which long term data are available show an average usage of 0.27 pounds per barrel of feed.

Operating Conditions—Although usually designed for specific conditions for cracking a given feed stock, the Socony Airlift TCC unit has a wide range of flexibility in operating conditions. The major variables and their usual range include the following:

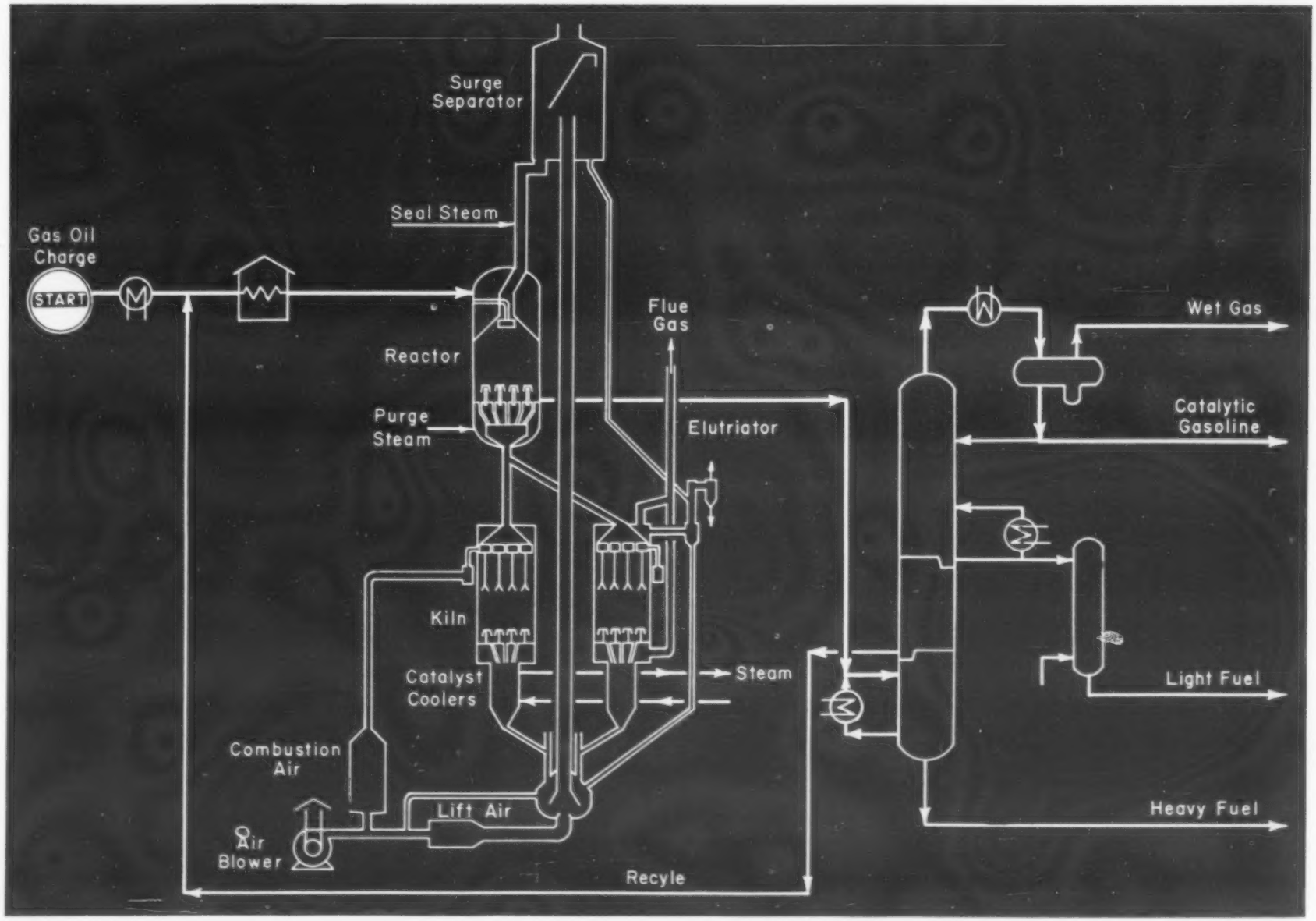
1) Space Velocity—1 to 2.5 volumes of oil per volume of catalyst in the reaction zone (V/Hr/V).
2) Catalyst-to-Oil Ratio—2 to 5 volumes of catalyst per volume of oil (V/V).
3) Average Reactor Temperature—840 to 920 F.
4) Catalyst Activity—25 to 34 CAT-A Index.
5) Recycle to Fresh Feed—0 to 2 volumes of recycle per volume of fresh feed.

Yields—See table.

Commercial Installations—At the present time there are 45 airlift TCC units in operation; 26 in the U. S. and 19 in foreign countries. Six additional units are licensed or under construction. These various units cover a range of fresh feed capacities from 1600 bpd to 35,000 bpd. Respective carbon burning capacities are 1100 pounds per hour to 29,000 pounds per hour. The total throughput capacity of the 51 Airlift TCC units in operation or authorized is well over 600,000 bpd; including the older type elevator units, the total capacity of all TCC units is over 1 million bpd.

Reference—PETROLEUM REFINER, vol 31, no 8, p 71 (Aug, 1952).

Yields:		
Crude Type	Mid-East & Venezuela	Kansas
Gasoline	43.3% Vol.	56.3% Vol.
Light Cycle Stock	27.1% Vol.	15.0% Vol.
Heavy Cycle Stock	18.6% Vol.	17.0% Vol.
Butanes	7.5% Vol.	10.8% Vol.
Propanes	6.3% Vol.	8.8% Vol
Ethane and Lighter Gas	3.5% Wt.	2.3% Wt.
Coke	5.8% Wt.	5.2% Wt.
Properties:		
Charge Stock, Gravity, API	27.3°	26.5°
10% Distilled	670 F	657 F
50% Distilled	872 F	835 F
90% Distilled	995 F	1021 F
Gasoline, RVP	10.0	10.5
10% Distilled	115 F	137 F
50% Distilled	208 F	230 F
90% Distilled	36°	395 F
Octane No. Research with 3 ml TEL	96.6	97.2


Surge Separator
Seal Steam
Gas Oil Charge
START
Reactor
Purge Steam
Flue Gas
Elutriator
Wet Gas
Catalytic Gasoline
Kiln
Catalyst Coolers
Steam
Light Fuel
Combustion Air
Lift Air
Air Blower
Heavy Fuel
Recyle

Fluid Catalytic Cracking—ESSO RESEARCH AND ENGINEERING COMPANY

Application—The Fluid Catalytic Cracking process has come into existence primarily because of its ability to produce greater yields of gasoline of a higher octane number than the thermal cracking process, which it has largely displaced.

Charge—Feed stocks range in commercial operation from naphtha cuts to heavy gas oils and deasphalted residuums.

Product—High yields of motor gasoline are obtained, with clear octane numbers of 81-83 ASTM and 92-99 CFR. By-products, such as isobutane and light olefins for alkylation, polymerization, LPG or for synthetic rubber ingredients are recovered.

Description—In the process finely-divided catalyst is suspended in gas or vapor so that if flows through the equipment with flow characteristics resembling a liquid. Thus, it circulates continuously between reaction and regeneration zones. The heat from the regenerator is transferred to the reactor, thereby replacing the need for cooling surfaces in the regenerator and greatly reducing the preheat requirement for the feed.

The drawing is illustrative of a modern catalytic cracking unit. Gas oil is injected into the hot regenerated catalyst line just before it enters the reactor. The catalyst rate is regulated to maintain the required temperature of reaction. Having entered the reactor, the catalyst begins to settle, forming a dense bed, which resembles a violently boiling liquid with a rather clearly defined level. Vapors leave the reactor through cyclone separators which return most of the entrained catalyst to the bed. Cracked products are then separated in conventional fractionation and absorption equipment.

In the reactor, the catalyst accumulates a carbonaceous deposit in the form of coke. After stripping to remove any retained hydrocarbons, this spent catalyst is transferred to the regenerator by the injection of a stream of air into the transfer line below the regenerator. The major portion of the air is supplied to the regenerator directly to burn the coke from the catalyst. The heat of combustion is absorbed by the regenerated catalyst, which in its turn supplies it to the feed stock to effect vaporization. Regenerated catalyst is supplied to the reactor through the other transfer line under its own prsesure head.

Since the first Fluid Catalytic Cracking unit was installed 14 years ago, the process has been repeatedly simplified and improved. The Model IV unit, which is shown in the accompanying drawing, incorporates the most recent engineering modifications designed by Esso Research and Engineering Company. A new and unique patented catalyst circulation system and other changes have made sharp reductions in the over-all size and height of the catalytic cracking unit, with a resulting lowering of investment and maintenance costs. A Model IV unit is 70 percent as high as its immediate predecessor. Reductions in the order of 20 perecnt in investment cost and corresponding lowering of steel requirements result.

Recycle operations have been found attractive in many cases. The flexibility of the process has been amply demonstrated. Service factor levels have been high, with uninterrupted runs of as much as three years. High catalyst recovery has been achieved in commercial plants, with losses being lower than the desired replacement rate for maintaining catalyst activity.

Commercial Installations—It is estimated that by the end of 1956 there will be about 3.6 million barrels per stream day (total feed) Fluid Catalytic Cracking capacity throughout the world, 2.7 million barrels per day of this being in the United States. There are nearly 200 units built, building, or contracted. In the case of the Model IV unit, installations now operating, under construction, or planned represent an operating capacity of about 660,000 barrels per stream day. Some details on these Model IV units are given in the accompanying table.

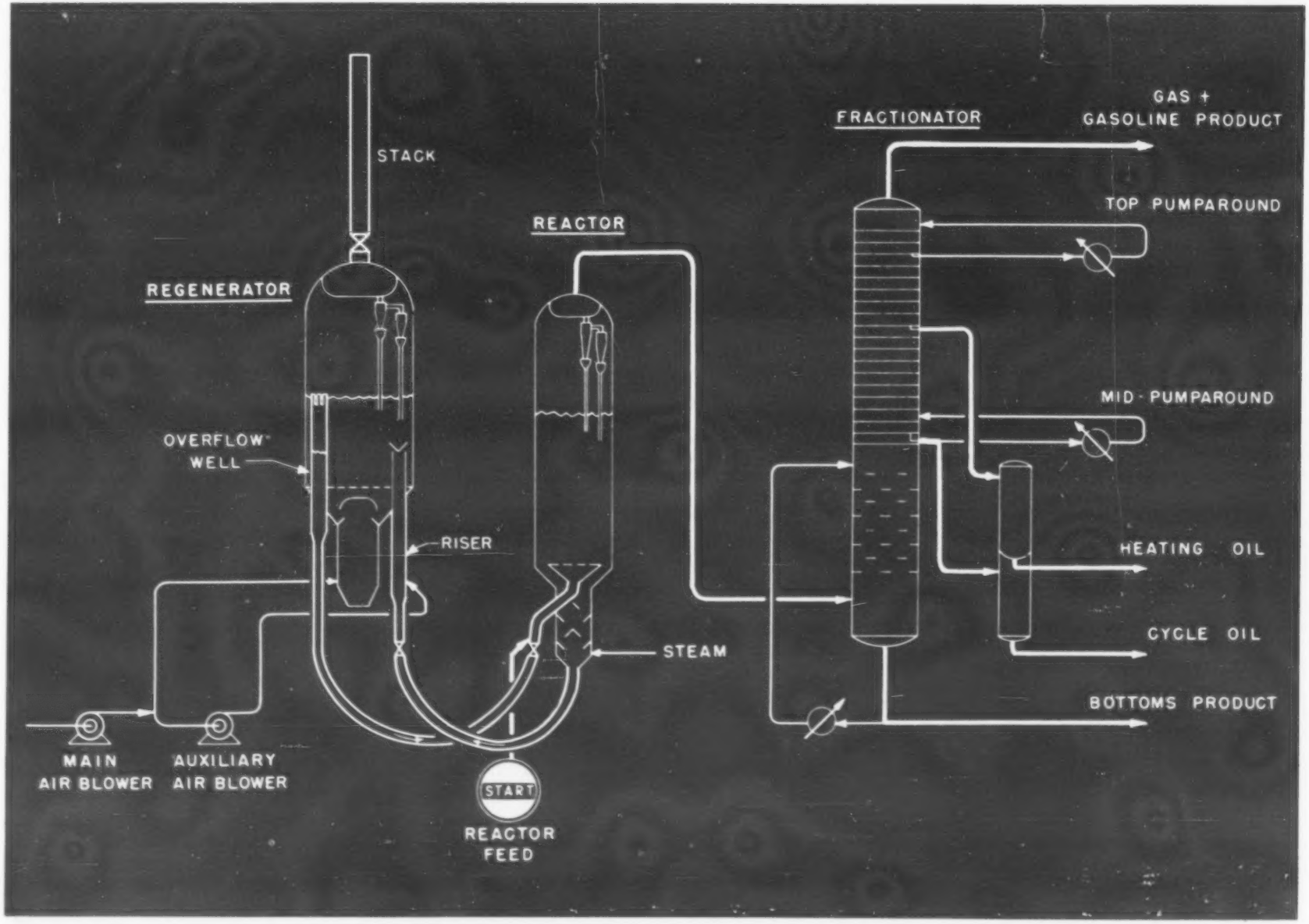
Reference—PETROLEUM REFINER, vol 35, no 4, p 201 (Apr, 1956).

MODEL IV FLUID CATALYTIC CRACKING UNITS

(Constructed, Building, and Approved)

COMPANY	Location	Capacity Total Feed B/D	Date on Stream	Builder
Imperial Oil Limited	Edmonton, Alberta	11,000	Dec., '52	Foster Wheeler
Imperial Oil Limited	Sarnia, Ontario	25,000	Mar., '53	M. W. Kellogg
Esso Std. Soc. An. Fr.*	Port Jerome, France	15,400	July, '53	Foster Wheeler
Esso Std. Ref. Soc. An.*	Antwerp, Belgium	9,360	July, '53	Lummus
Esso Std. Oil Co.*	Everett, Mass.	24,000	July, '53	Foster Wheeler
Imperial Oil Limited	Ioco, British Columbia	12,600	Nov., '53	Bechtel
Esso A.G.*	Hamburg, Germany	9,360	Dec., '53	Gutehoffnungshuette, A.G.
Std.-Vacuum Oil Co.*	Durban, South Africa	9,740	Jan., '54	Foster Wheeler
Imperial Oil Limited	Regina, Saskatchewan	13,600	May, '54	Fluor
Std.-Vacuum Oil Co.*	Bombay, India	9,360	July, '54	Lummus
Empresa Col. de Pet.	Barrancabermeja, Col.	19,280	Sept., '54	Foster Wheeler
Imperial Oil Limited	Halifax, Nova Scotia	27,000	July, '56	Foster Wheeler
Std.-Vacuum Oil Co.*	Wakayama, Japan	20,000	Nov., '56	Refinery
Esso Std. Soc. An. Fr.	Port Jerome, France	23,150	April, '57	Refinery
Int. Petroleum (Colombia), Ltd.	Cartagena	25,000	Aug., '57	Bechtel
Esso Std. Oil S.A.	Belot, Cuba	24,000	Aug., '57	
Std.-Vacuum Oil Co.	Palembang, Sumatra	22,500	Sept., '57	Foster Wheeler
Comp. Nat. de Pet.	Campana, Argentine	13,300	Nov., '58	
Total for Standard Oil Co. (N.J.) Affiliates		313,650		
Pan.-Am Southern Corp.	Destrehan, La.	15,000	Nov., '52	Lummus
Cie. Francaise de Raf.*	LaMede, France	14,740	July, '53	Lummus
International Ref., Inc.*	Wrenshall, Minn.	4,880	Aug., '53	Lummus
Lion Oil Company	El Dorado, Ark.	10,800	Dec., '53	Lummus
Pan American Ref. Corp.	Texas City, Texas	30,000	Jan., '54	Lummus
Std. Oil Co. of Calif.	El Segundo, Calif.	55,000	Sept., '54	Fluor
Calif. Texas Oil Co., Ltd.	Batangas, P.I.	10,800	Oct., '54	Foster Wheeler
Calif. Texas Oil Co., Ltd.	Yokohama, Japan	10,800	Dec., '54	Arthur G. McKee
Std. Oil Co. of B.C., Ltd.	Vancouver, B.C.	6,000	Dec., '54	Fluor
Salt Lake Ref. Co.	Salt Lake City, Utah	6,000	Aug., '55	Fluor
Calif. Texas Oil Co., Ltd.	Kurnell, Australia	30,000	Dec., '55	Foster Wheeler
Cie. Francaise de Raf.	Le Havre, France	30,000	May, '56	M. W. Kellogg
Std. Oil Co. of Calif.	Honolulu, T.H.	22,000	(1957)	Bechtel
Calif. Texas Oil Co., Ltd.	Visakhapatnam, India	14,700	(1957)	Foster Wheeler
Petroleos Mexicanos	Atzcapotzalco, Mexico	25,000	(1957)	Arthur G. McKee
Std. Oil Co. of Texas	El Paso, Texas	30,000	(1957)	
Total Non-Jersey		315,720		
TOTAL		629,370		

* Combination Unit.


STACK
REGENERATOR
REACTOR
FRACTIONATOR
GAS + GASOLINE PRODUCT
TOP PUMPAROUND
MID-PUMPAROUND
OVERFLOW WELL
RISER
STEAM
HEATING OIL
CYCLE OIL
BOTTOMS PRODUCT
MAIN AIR BLOWER
AUXILIARY AIR BLOWER
START
REACTOR FEED

Fluid Catalytic Cracking—THE M. W. KELLOGG COMPANY

Application—For Fluid Catalytic Cracking the "Orthoflow" system and design are recommended for the production of high octane gasoline at lowest investment cost.

The Orthoflow, developed and licensed by the M. W. Kellogg Company, design provides straight-line flow of catalyst between the vessels, virtually eliminating erosion normally encountered in pipe bends.

The Orthoflow principle has been developed in two alternative forms, both in successful commercial operation. In one system (A) the regenerator is located beneath the reactor and in the other (B) it is positioned above the reactor. Both systems have economic applications, the choice depending upon local cost factors. Both realize an unique degree of simplicity of construction, operation and maintenance.

Charge—Feed stocks consist of a wide range of gas oils from atmospheric or vacuum distillation, or from solvent decarbonizing, visbreaking or delayed coking.

Products—High octane gasoline, heating oil, blending stock, diesel oil and fuel oil constituents, light olefins for alkylation or polymerization and fuel gas.

Description—A simplified flow diagram of the Orthoflow Fluid catalytic cracking process is shown on the opposite page.

Fresh gas oil feed and recycle from the fractionator enter the base of the reactor through a distribution system. Hot regenerated catalyst flows downward through standpipes, contacts the oil vapors, and is carried up into the reaction zone in sufficient quantity to maintain the reaction temperature. A catalyst bed level is established in the reactor to give the required space velocity. Oil vapors from the cracking reaction are separated from entrained catalyst in internal cyclones and carried to the fractionator.

The spent catalyst stripping zone is positioned centrally within the reactor. Stripped spent catalyst is conveyed upward to the regenerator section with a portion of the regeneration air, which is admitted through the hollow stem of the spent catalyst plug valve. In the regenerator the spent catalyst is contacted with additional air to reduce the carbon content to the desired level. Internal cyclones are used to separate regenerated catalyst from the flue gas stream leaving the top of the regenerator.

In the fractionator, the reactor effluent is separated into gasoline, light gas oil, a recycle stream, and a slurry stream. The recovery and finished gasoline plant consists of absorption and stabilization units to produce a high grade of gasoline. A highly olefinic feed stock suitable for catalytic polymerization or alkylation can also be recovered.

Through the construction of the reactor and the regenerator in a single vessel and the use of straight internal catalyst carrier lines, the Orthoflow represents the simplest design to date. One of the major design achievements was the development of plug valves which regulate internal catalyst flow. These valves eliminate the need for expansion joints in many instances and are more easily maintained than conventional slide valves. The operating history of Orthoflow units has been remarkably free of erosion difficulties. The rate of erosion of the plugs is considerably less than with slide valves and, unlike slide valves, the plugs inherently compensate for wear without loss of control. The plug valve assemblies are mounted for easy replacement when required.

Operating Conditions

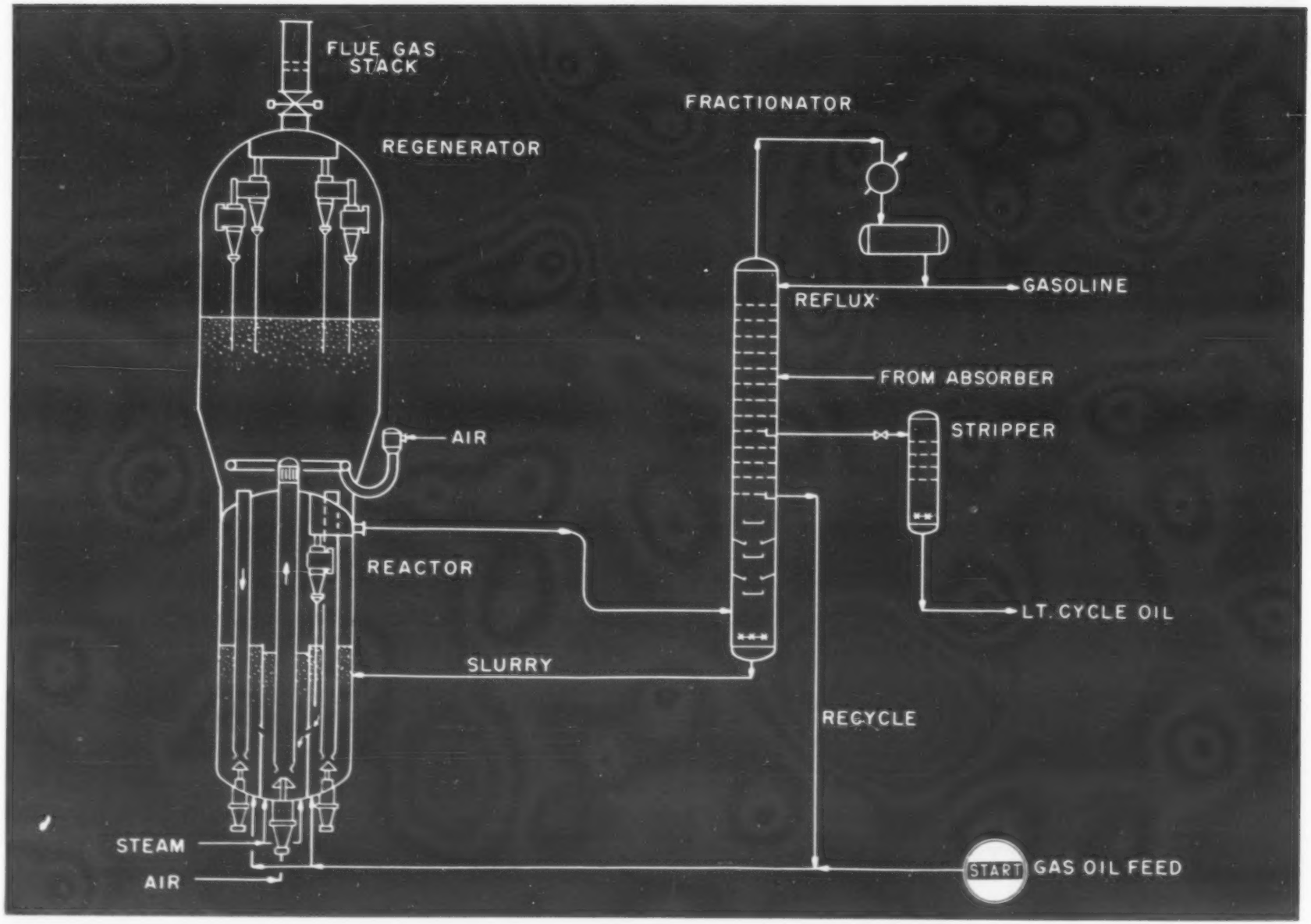
Reactor Temperature	885-950 F.
Reactor Pressure	14-16 psig
Regenerator Temperature	1050-1100 F.
Regenerator Pressure	8-10 psig
Catalyst/Oil Ratio	8-12 C/O
Space Velocity	1.0-3.0 W/Hr./W

Yields

Typical Yields From an Orthoflow F.C.C.U.

Fresh Feed, mixed gas oil, bbl. per day	17,600
Gravity, °A.P.I.	28.0
Throughput ratio	1.5
Conversion, volume percent	70.8
Tail gas, weight percent	7.8
C_3 to poly, weight percent	6.9
C_4 + gasoline, volume percent	58.0
Light cycle oil (No. 2 fuel), volume percent	23.5
Debutanized gasoline:	
Gasoline, °A.P.I.	58.0
R.V.P., psi	7.0
50 percent point, °F	210
End Point, °F	420
C.R.R.-R. Clear	92.0

Commercial Installations—At present, 17 units of the Orthoflow design are operating or in various stages of completion. This number represents a total throughput capacity of 410,000 barrels per day.


FLUE GAS STACK
REGENERATOR
FRACTIONATOR
GASOLINE
REFLUX
FROM ABSORBER
STRIPPER
AIR
REACTOR
LT. CYCLE OIL
SLURRY
RECYCLE
STEAM
AIR
START
GAS OIL FEED

Fluid Catalytic Cracking—SHELL DEVELOPMENT COMPANY

Application—The Two-Stage Fluid Catalytic Cracking process is a new cracking technique for providing higher gasoline and lower coke yields while permitting greater flexibility for shifting production between maximum gasoline and maximum intermediates.

Charge—Conventional catalytic cracking feed stocks.

Products—Conventional, but with different distribution.

Description—The flow pattern for the process is shown in the accompanying diagram. The feed and hot regenerated catalyst travel concurrently up through a riser. This riser comprises the first stage reactor in which the retention time is very short. The material from the riser passes into a high-load separator where the partially spent catalyst is removed from the products of the first stage cracking. The products are sent to a fractionator to remove the desired products so that they will not be destroyed by subsequent cracking.

The unconverted or insufficiently converted materials are removed from the fractionator as a bottoms material and sent to the second stage reactor vessel. Here the partially spent catalyst again contacts the hydrocarbons and additional cracking is achieved. The vapor from the second stage cracking is separated by fractionation into the various boiling range products. The spent catalyst is passed to a regenerator and then recycled back to the first stage reactor riser.

The Two-Stage Fluid Catalytic Cracking process is used to achieve optimum yields from various feed stocks. When cracking is carried out in one stage the least refractory components are cracked too severely and yield large amounts of gas and coke while the more refractory components undergo only low conversion. This overcracking and undercracking prevents the realization of optimum yields.

The first stage reactor is operated at high temperatures so that the coke yields are kept low. This condition would have the disadvantage of distructively cracking some of the gasoline components of the charge, if it were not for the very short retention time. By sending the materials from the first stage reactor to a fractionator, the material that might otherwise be overcracked can be removed from the cracking zones. The more refractory materials can then be given a longer more thorough cracking in the second stage reactor.

The catalyst for the second stage operation is supplied from the first stage separator. The partially used condition of this catalyst does not hamper the second stage cracking.

In the two-stage cracking process, considerable flexibility is available for changing the yield structure from a given feed stock. For example, gasoline yield can be increased further by incorporating recycle into one of the cracking stages. On the other hand, in periods of high demand for intermediates, the yield of light gas oil may be increased substantially by charging only heavy gas oil to the second stage reactor.

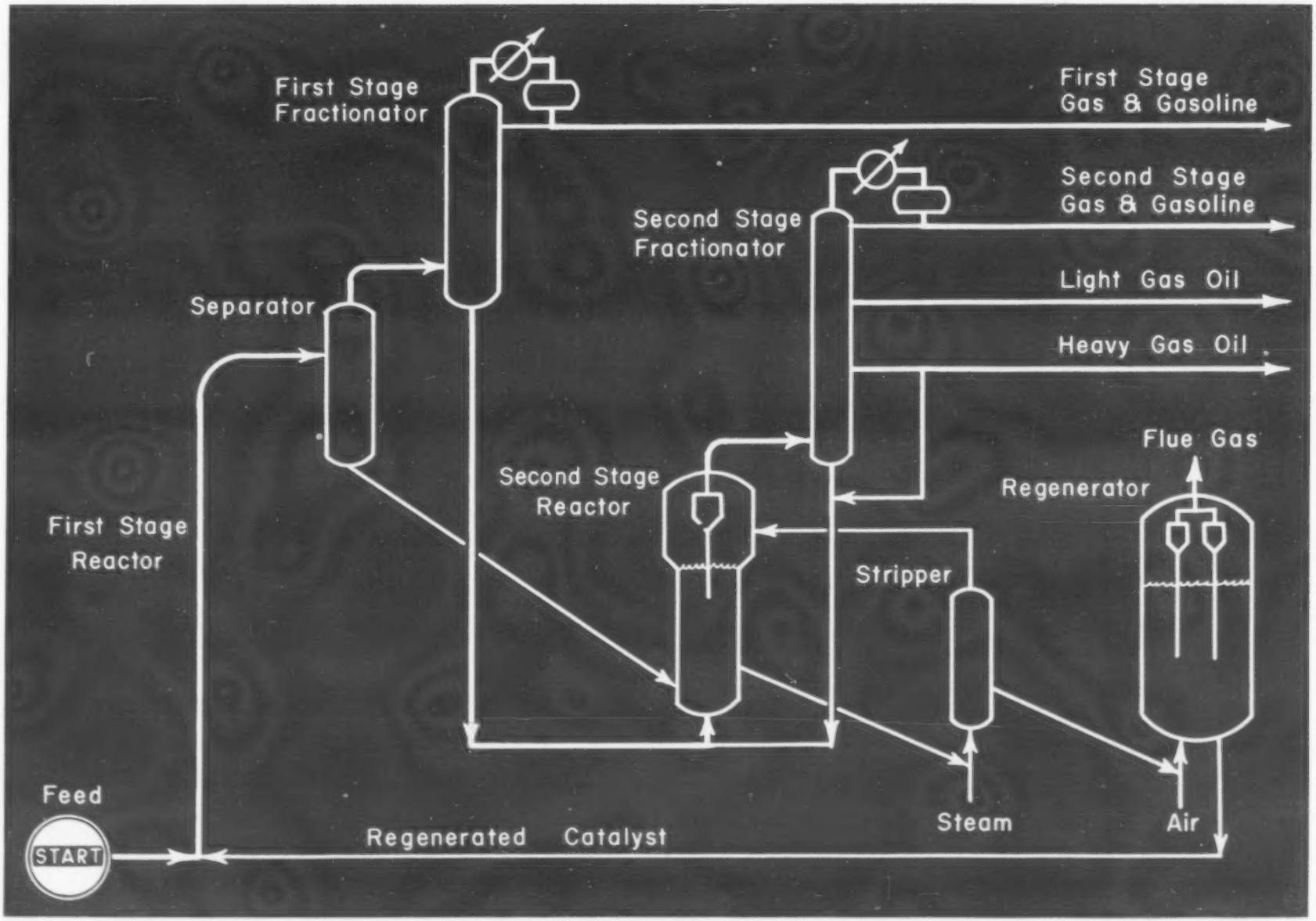
The principles described here are not limited to new installations. Existing fluid units can, in some instances, be modified to take advantage of the short-contact-time and the two-stage principles by addition of a riser reactor and accompanying facilities. In cases where high conversion is not required, a single-stage riser reactor unit may be designed to take advantage of the increased selectivity.

Yields—Commercial operation has been on a mixture of Alberta feeds. The following table gives the properties of the feed and the distribution of the resulting products.

Alberta Feed-Stock	
API gravity	23.7
ASTM Distillation, Degrees Fahrenheit:	
IBP	508
10 percent by volume	620
Pour point, degrees fahrenheit	+85
Ramsbottom carbon residue, percent by weight	0.83
Sulfur, percent by weight	1.26
Viscosity at 210 F, SSU	51
Product Distribution, Volume Percent Unless Shown:	
Ethane and lighter (std. cu. ft. per bbl.)	(340)
Propylene	8.0
Propane	4.5
Butylenes	12.7
Butanes	5.1
Debutanized gasoline	53.3
Light gas oil	12.2
Heavy gas oil	12.4
Coke, percent by weight	(6.5)
Conversion	75.4

Commercial Installations—The first commercial unit employing this new technique was built in Shell's refinery at Anacortes, Washington. This process is licensed by the Shell Development Company through Universal Oil Products and the M. W. Kellogg Company.

Reference—PETROLEUM REFINER, vol 35, no 5, p 166 (May, 1956).


First Stage
Fractionator
First Stage
Gas & Gasoline
Second Stage
Gas & Gasoline
Second Stage
Fractionator
Light Gas Oil
Heavy Gas Oil
Separator
Flue Gas
Second Stage
Reactor
Regenerator
First Stage
Reactor
Stripper
Feed
START
Regenerated Catalyst
Steam
Air

Fluid Catalytic Cracking—UNIVERSAL OIL PRODUCTS COMPANY

Application—UOP Fluid Catalytic Cracking is a high-temperature, low-pressure process utilizing the fluid technique to circulate catalyst. It is employed primarily to convert distillate oils into high octane gasoline and to reduce the overall refinery fuel oil production. Current designs are noted for simplicity, ease of operation and low operating and investment costs.

Charge—A wide variety of stocks from all types of crudes may be charged. Typical feeds may be either virgin or cracked and include naphtha, kerosine, light gas oils, wax distillates, atmospheric and vacuum gas oils and distillates from vis-breaking and coking. Feeds may be high in nitrogen and sulfur compounds and, in some cases, may include some desalted crude.

Description—A typical flow diagram for a 5000 bpsd unit is shown, featuring reactor and regenerator in a single vessel. The gas oil feed, cold or hot, is charged together with recycle into the hot regenerated catalyst stream, is vaporized, and passes to the reactor. Vapors from the reactor, carrying some catalyst, pass upward through the reactor cyclone separator, which removes most of the entrained catalyst, and into the fractionating column.

The spent, or used, catalyst passes downward from the reactor through the steam stripper and enters the regenerator where the carbon deposit is burned off. Oxygen for combustion is supplied by air from the air blower. The flue gases carrying some catalyst pass upward through the regenerator cyclone separators where entrained catalyst is removed, and pressure is released in a pressure reducing chamber which serves as a noise eliminator. The regenerated catalyst again enters the incoming gas oil charge stream to repeat the cycle.

An external feed preheater is optional. The initial heat to bring the unit on stream is supplied by a direct-fired air preheater and torch oil in the regenerator.

The fractionating column is of standard UOP design, with gasoline taken overhead and one or more selected fractions withdrawn as sidecuts. The net column bottoms are sent to storage via the slurry settler. Steam may be generated by recovery of heat in the fractionator column bottoms. Catalyst-containing oil from the bottom of the slurry settler is returned to the reactor with the fresh feed.

The unstabilized gasoline and gas pass to a gas fractionation section for debutanization and recovery of C_3—C'_4 polymerization unit feed.

The UOP regenerator design utilizes pressure to increase the coke-burning rate, which permits a smaller sized regenerator and correspondingly less catalyst inventory. The catalyst inventory of a 5000 bpsd unit with a coke burning capacity of 4233 pounds per hour at 53 percent conversion (gas oil disappearance) is approximately 37 long tons. Catalyst loss at 53 percent conversion will not exceed 0.25 pound per barrel of fresh feed; at 70 percent conversion, loss will not exceed 0.40 pound. This is approximately equivalent to desirable make-up rates in maintaining constant catalyst activity.

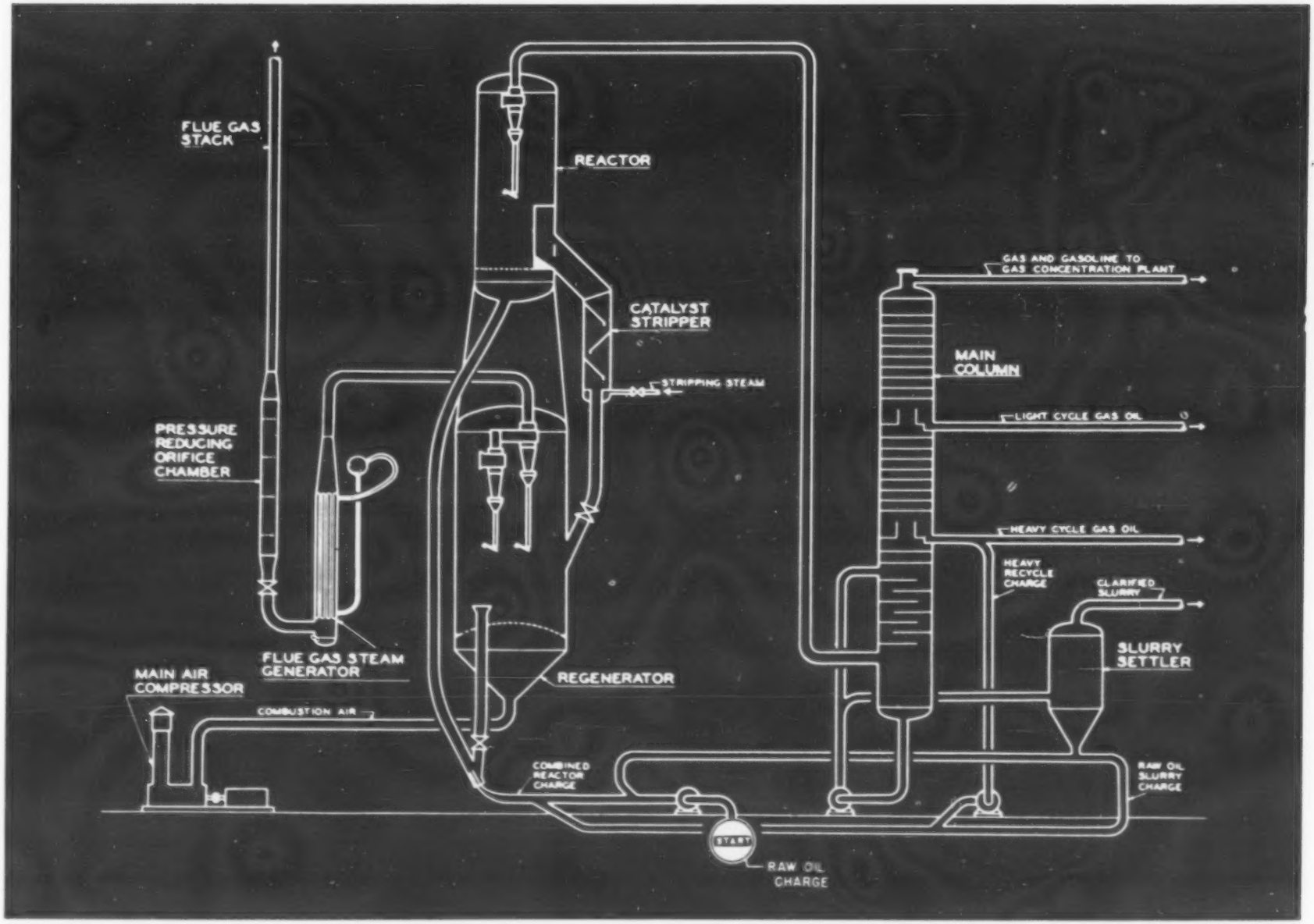
The design of this unit imparts particular flexibility. The unit can handle a rather wide range of catalyst-to-oil ratios to suit individual process requirements. It can process a totally liquid feed, provision is made to change reactor space velocity at will, reactor temperature can be varied over a wide range and a high clear octane product is produced. Moreover, installation and operating costs are low. Approximately 90 percent of the heat generated by burning off the catalyst is recovered in maintaining reactor temperature and by steam generation.

Yields—Typical yields when cracking a 28° API Mid-Continent gas oil in once-though and recycle operations are given in the table.

OPERATION	Once Through	Recycle
Conversion	60	75
Yields (Volume Percent):		
Debutanized Gasoline	45.2	53.5
Light Cycle Oil	28	21
Heavy Cycle Oil	12	4
Butylenes	5.9	8
Butanes	6.4	8
Propylene	5.0	6.4
Propane	2.9	3.7
C_2 and Lighter Gas, Wt. Percent	2.2	2.8
Octanes, 10-Lb. RVP Gasoline:		
Motor Method (F-2) Clear	81.5	81.5
3 cc. TEL	86.5	86.5
Research Method (F-1) Clear	93.5	93.5
3 cc. TEL	98.5	98.5
Yields with Polymerization (Volume Percent):		
10 Lb. RVP Polymer Gasoline	7.6	10.0
10 Lb. RVP Catalytic Cracked Gasoline	47.6	56.4
Total 10 Lb. RVP Gasoline	55.2	66.4

Commercial Installations—There now are over 70 UOP-designed fluid cracking units in operation or under construction. Sizes range from 1400 to approximately 35,000 upsd of fresh feed and represent a design throughput capacity of nearly 500,000 bpsd.

Reference—PETROLEUM REFINER, vol 30, no 3, p 130 (Mar, 1951).


FLUE GAS STACK
REACTOR
GAS AND GASOLINE TO GAS CONCENTRATION PLANT
CATALYST STRIPPER
MAIN COLUMN
STRIPPING STEAM
PRESSURE REDUCING ORIFICE CHAMBER
LIGHT CYCLE GAS OIL
HEAVY CYCLE GAS OIL
HEAVY RECYCLE CHARGE
CLARIFIED SLURRY
SLURRY SETTLER
FLUE GAS STEAM GENERATOR
REGENERATOR
MAIN AIR COMPRESSOR
COMBUSTION AIR
COMBINED REACTOR CHARGE
RAW OIL SLURRY CHARGE
START
RAW OIL CHARGE

Houdriflow & Houdresid—HOUDRY PROCESS CORPORATION

Application—The Houdriflow catalytic cracking process is used to produce high-octane motor and aviation fuels from a wide range of petroleum distillate fractions.

Charge—Reactor feed may be liquid, vapor, or a mixture of both. All but one of the 20 Houdriflow cat-crackers now operating are charging stocks well over 50 percent liquid; in some instances, the feed is completely liquid phase, and if desired may consist solely of accumulated cycle stock.

Sweet and sour stocks are handled by Houdriflow units with equal ease, as are any fractions from the crude boiling between naphtha and penetration asphalt. Catalyst may be either natural or synthetic.

Products—Excellent yields of motor gasolines are obtained with octane values ranging from 88-94 F-1 clear to 95-99 with 3 cc. TEL, depending upon charge stocks, operating temperatures, and type of catalyst employed.

Description—The Houdriflow process is distinguished for its (a) ease of operation under normal and emergency operating conditions, (b) low maintenance and operating cost, (c) high catalyst activity in conjunction with low catalyst make-up cost, and (d) flexibility as to charge stocks handled and conversion levels attained.

Evidence of the efficiencies embodied in this continuous moving-bed catalytic cracking process may be found in its compact disposition within a ground area approximately 40 by 60 feet.

The integrated catalytic reactor and regenerating kiln, comprising a single vessel, and the hot catalyst storage vessel, are self-supporting. They are customarily located on opposite sides of a steel structure housing a stairway and supporting the catalyst lift and elutriator. A pneumatic lift system recirculates regenerated catalyst.

Operating Conditions—Normal operating conditions fall within the following ranges: Temperature 850-925 F.; Pressure 9-10 psig; Space velocity 1.5-4 v/hr/v; and Catalyst-oil ratio 3-7.

Yields—Conversion above 90 percent has been achieved in some units, with relatively low coke deposit, using recycle ratios of 1 to 1 or slightly more. Where once-through cracking is preferred, conversion of from 50 to 60 percent may be obtained.

Charge, BPSD:[1]	A	B	C
Virgin gas oil	5,810	4,460	4,750
First pass cat. gas oil	1,430	—	—
Recycle	—	2,200	5,700
Total	7,240	6,660	10,450
Products:			
Gasoline,[2] Vol. %	40.8	53.7	67.8
Gas oil, Vol. %	50.3	31.1	9.2
C_3-C_4 recovered, Vol. %	16.1	18.6	25.0
Liquid recovery, Vol. %	107.2	103.4	102.0
Fuel gas, wt. %	3.8	5.8	7.3
Catalyst deposit, wt. %	5.2	5.4	9.0
Gasoline octanes:			
F-1 Clear	91.5	90.6	89.3
F-1 + 3 cc TEL	—	—	96.7
F-2 Clear	81.7	—	—

[1] Charge stocks are atmospheric plus vacuum gas oils from: (A) Texas pipe line crude, (B) Scurry crude, and (C) Hutchinson-Moore County, West Texas, crude.
[2] Gasoline basis: 10 psi RVP and 380 F at 90 percent distilled.

Commercial Installations—Since introduction of the process, 20 Houdriflow units have been constructed and another is under construction. The largest Houdriflow currently in operation has a design capacity of 27,000 BPSD, the smallest 3650 BPSD. Total nominal design capacity of all Houdriflow catalytic crackers in operation and under construction is 278,430 BPSD.

Reference—PETROLEUM REFINER, Vol. 31, No. 5, p. 133 (May, 1952).

Application—The Houdresid catalytic cracking process is used to produce high-octane gasoline and light distillate fuels from reduced crudes.

Charge—Residua high in sulfur and nitrogen may be charged. Novel process features prevent the adverse effects on product selectivity heretofore resulting when heavy metals, such as nickel and vanadium, are present in the feed.

Residuum cuts ranging from atmospheric tower bottoms to vacuum bottoms may be charged to the Houdresid catalytic unit, thus permitting refineries greater flexibility in the kind of crude that may be run. If desired, the entire crude may be charged.

Products—Octane values of the gasoline produced by Houdresid catalytic cracking are in the 90-95 F-1 clear range. Moreover, the Houdresid process eliminates heavy residual fuel as its name implies.

Description—Under commercial conditions, catalyst use is substantially the same as experienced with conventional Houdriflow cracking, indicating no necessity for withdrawal of catalyst, over requirements from normal mechanical loss, in order to maintain high selectivity and activity levels.

Either synthetic or natural catalyst may be used. An inexpensive natural catalyst has been found to be particularly well suited to commercial Houdresid processing.

Yields—Reduced crude from mixed Mid-Continent, Texas, and Louisiana crudes processed in a Houdresid commercial cracker attained conversion ranges of 65-70 volume percent, depending on changes in throughput, recycle ratio, space rate, catalyst-oil ratio, and temperature.

C_5 + gasoline yields varied from 48 to 53 volume percent, and coke (as deposit on catalyst) between 5.9 and 8.2 weight percent.

The Houdresid process provides a greater potential polymer gasoline yield from polymerization of C_3 and C_4 cuts for blending into final high-octane product, as well as favorable proportions of No. 2 domestic fuel oil.

Commercial Installations—One Houdresid unit has been in daily refinery production for over two years, and two other large units now on stream are equipped for both Houdriflow gas oil and Houdresid bottoms catalytic cracking.

Reference—PETROLEUM REFINER, vol 34, no 6, p 153 (June, 1955).

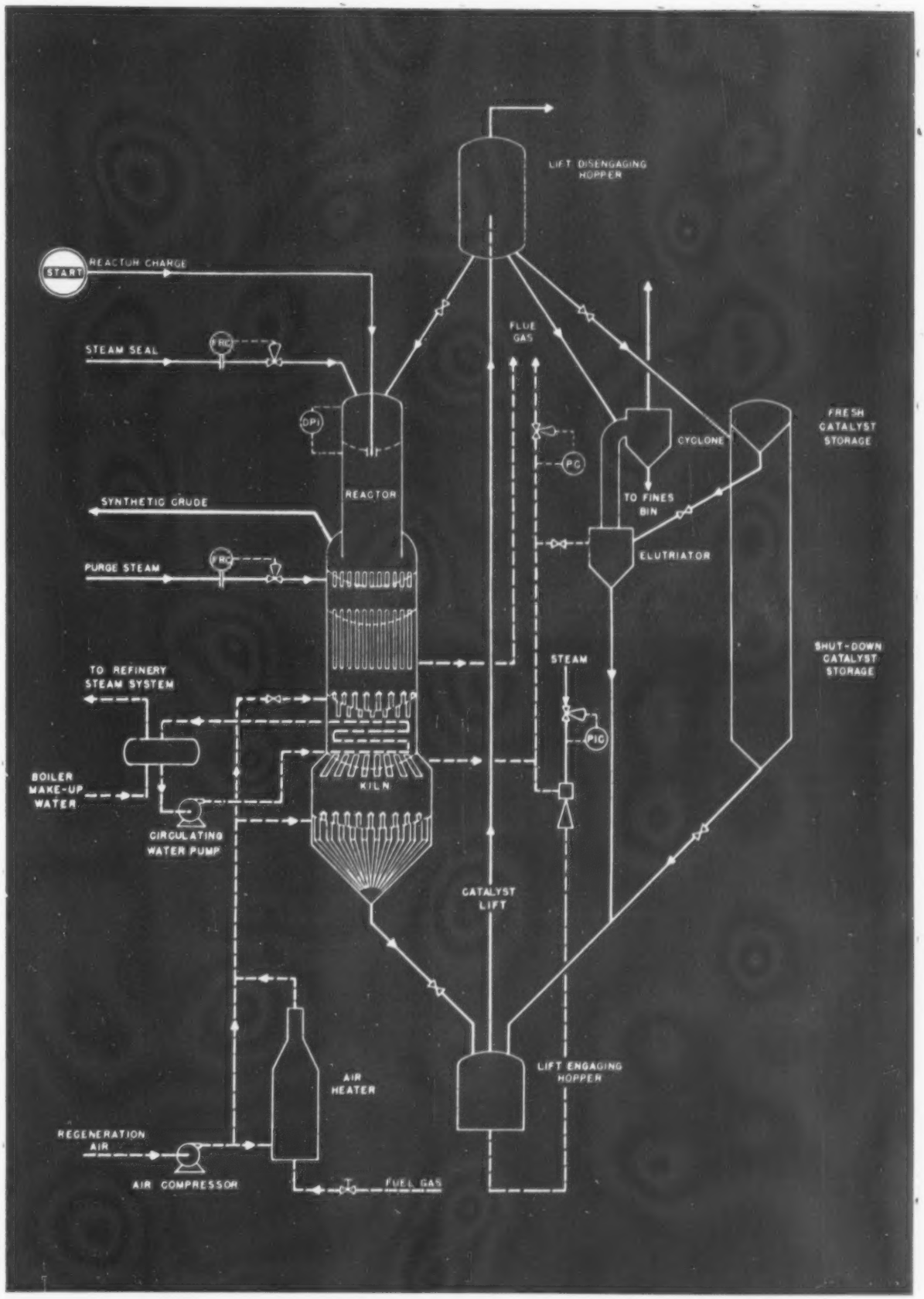
Heavy Residua

Charge Inspection			
% Reduced Crude	10[1]	10.6[2]	4.1[2]
Gravity, °API	12.6	17.7	12.7
Sulfur, wt %	0.91	0.72	1.02
Yields, based on fresh feed once through			
Debutanized Gasoline, vol %	40.1	42.6	40.4
Cat Gas Oil, vol %	40.2	37.0	27.1
C_4 Fraction, vol %	10.4	13.1	15.6
Dry Gas, wt %	7.3	11.6	13.5
Coke, wt %	16.3	8.5	17.6
C_5 + Gasoline, F-1 Octane, clear	89.3	93.4	90.7

(1) South Central Texas Mixed Reduced Crude
(2) Mid-Continent, Texas, and Louisiana Mixed Reduced Crude

Mid-Continent, Texas, and Louisiana Mixed Crude

Charge Inspection		
Gravity, °API	26.9	
Sulfur, wt %	0.47	
Charge Rate, B/SD		
Reduced Crude	5,020	6,410
Recycle	2,340	3,600
Total	7,360	10,010
Yields, based on fresh feed		
Conversion, vol %	67.6	67.6
Debutanized Gasoline, vol %	48.5	51.6
C_4 Fraction, vol %	14.8	13.1
Dry gas, wt %	10.3	7.9
Coke, wt %	7.1	5.9
Hydrogen, SCF/C converted	129	138
C_5 + Gasoline Inspection		
F-1 Octane, clear	93.0	91.6
Sulfur, wt %	0.08	0.08


LIFT DISENGAGING HOPPER
START
REACTOR CHARGE
STEAM SEAL
FRC
DPI
FLUE GAS
PC
CYCLONE
FRESH CATALYST STORAGE
REACTOR
SYNTHETIC CRUDE
TO FINES BIN
PURGE STEAM
FRC
ELUTRIATOR
SHUT-DOWN CATALYST STORAGE
STEAM
TO REFINERY STEAM SYSTEM
PIC
KILN
BOILER MAKE-UP WATER
CIRCULATING WATER PUMP
CATALYST LIFT
AIR HEATER
LIFT ENGAGING HOPPER
REGENERATION AIR
AIR COMPRESSOR
FUEL GAS

Coking—

Application—The process is used to produce clean gas oils which are suitable for thermal or catalytic cracking. In this way additional gasoline and light products are obtained from a given quantity of crude.

Charge—Reduced crudes, cracked tars, heavy catalytic cycle oils, and asphalts.

Products—Gas oil, gasoline, gas and coke.

Description—In the coking process the feed is heated and charged to the lower portion of a fractionator. Here the charge meets the hot vapors from the coking drum and the light components are flashed from the charge. Some installations use stripping steam to assure adequate removal of these light materials.

The heavy residue is taken from the bottom of the fractionator and passed through a furnace where it acquires the heat of cracking. The design of the furnace is such that a minimum of coke is layed down within the furnace coils. This is achieved by choosing the proper fluid velocity and heat transfer for the critical region within the furnace where coking is likely to occur.

The heated residue is introduced into an insulated drum where the residence time is sufficient for coke to form and settle from the mixture. The vapors from the coking operation leave the top of the drum and return to the fractionator. Here the gas, gasoline, and gas oil products are separated and sent to storage or to subsequent processing units. The heavier products appear in the bottom of the fractionator and are recycled to the coking operation.

Most units have a side stream cooler or reflux system on the fractionating tower where some of the heat is used for steam generation. Other units use this heat to preheat the process charge.

In the coke drums the coke continues to build up until a predetermined level is reached. The flow is then diverted to another drum which has been preheated so that the furnace operation may be continuous. The switching of flow from one drum to another must be made quickly to avoid coking within the transfer lines.

A full coke drum which has been removed from the process is steamed to strip light hydrocarbons from the coke. It is cooled by water injection and the head removed. The coke dumping operation is then begun.

In early designs the coke was removed with pick and shovel. Later designs drilled a hole up through the coke formation and used a chain and ball mechanism to beat out the coke. More recent designs use high pressure water jets to cut the coke from the drum.

In the past it was considered necessary to have at least three coke drums to sustain continuous operation because of the difficulties encountered during coke removal. Now, however, units are designed for two coke drums. For greater capacities the unit may have as many as four or six coke drums. Even so they are operated in pairs with one drum on-stream while the other is being dumped.

The coke drums are usually operated on a 48-hour cycle. Each drum is given 24 hours on-stream and 24 hours off-stream. This has the advantage of requiring only one dumping crew, and their work may be scheduled to occur only during the day shift.

Operating Conditions—The normal range of operating conditions for which coking units have been designed are as follows:

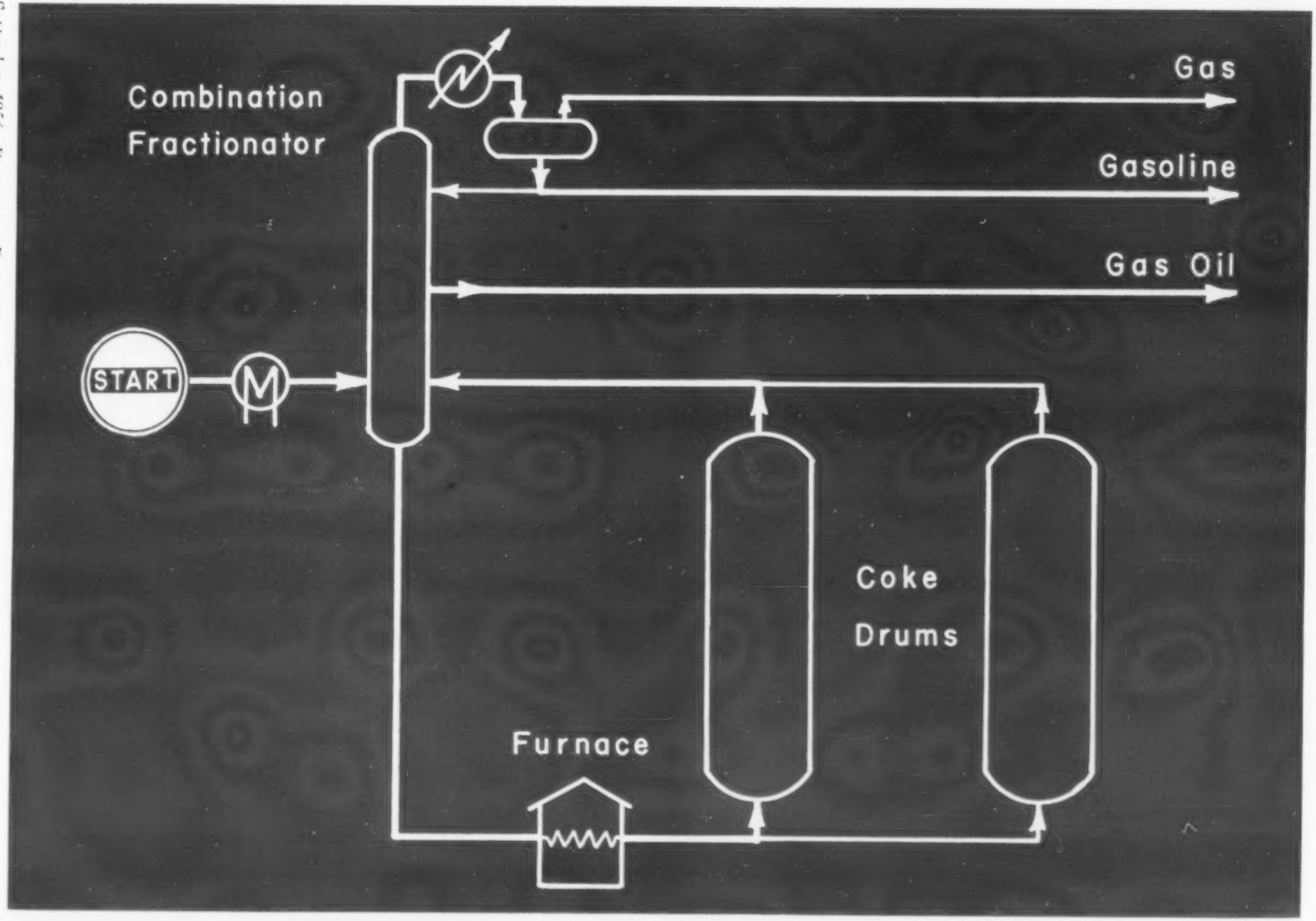
Furnace Outlet Temperature	900 - 940 F
Coke Drum Temperature	780 - 840 F
Coke Drum Pressure	10 - 70 psig

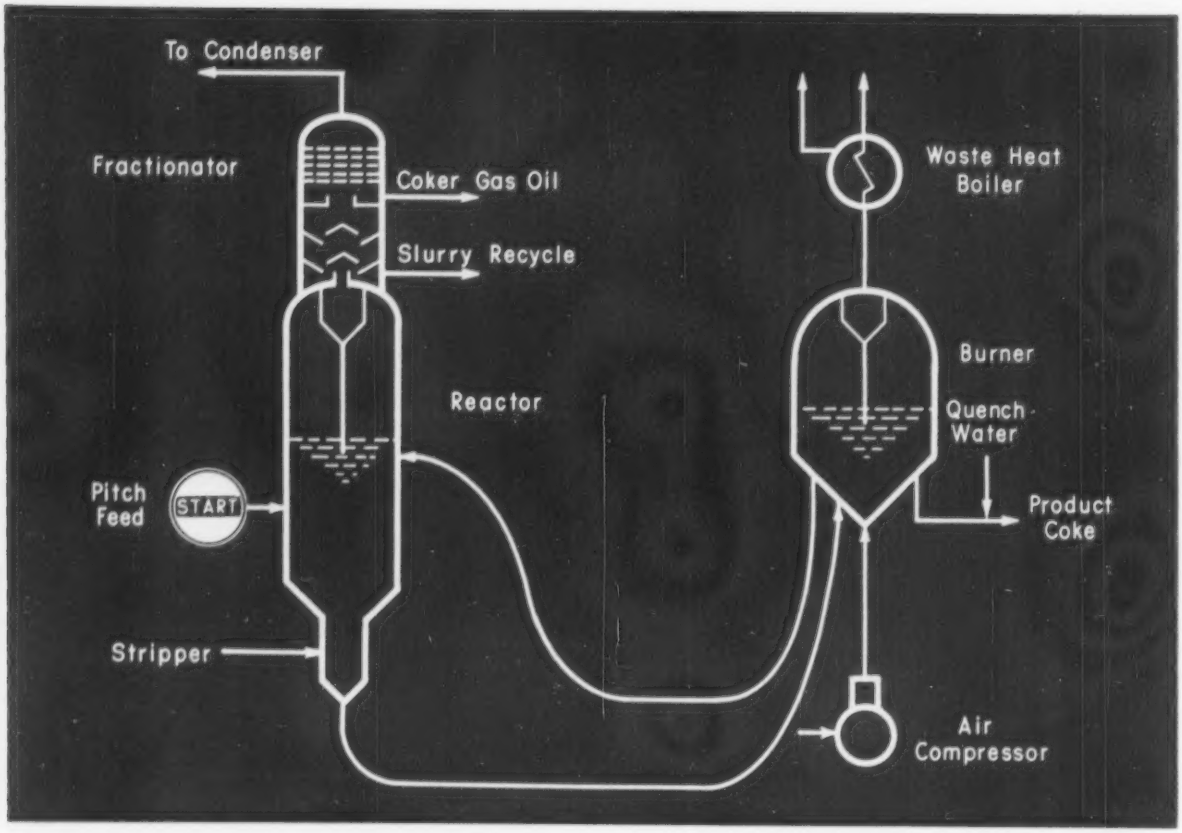
Yields—There is a wide variation in the product distribution from different coking units depending on whether gasoline is to be produced during the coking operation or during subsequent cracking of the coker gas oil. Gasoline yields may be from 5 to 25 volume percent of the charge to the coking unit.

Commercial Installations—In the U. S. and Canada there exists drum coking capacity to process about 380,000 barrels of feed per day. This is equivalent to about 11,000 tons of coke per day.

Reference—Coking units are designed and installed by several companies under various names. Process descriptions and yield data for most of these designs have been published in the PETROLEUM REFINER in recent years. Reference to these descriptions are given in the following table.

Company	Name	Reference: PETROLEUM REFINER
Blaw-Knox Company	Decarbonizing	Vol 32, No 7, p 106 (July, 1953)
Foster Wheeler Corporation	Delayed Coking	Vol 31, No 9, p 148 (September, 1952)
The M. W. Kellogg Company	Delayed Coking	Vol 32, No 7, p 108 (July, 1953)
The Lummus Company	Delayed Coking	Vol 32, No 7, p 102 (July, 1953)
Union Oil Company of California	Delayed Coking	Vol 34, No 7, p 149 (July, 1955)
Universal Oil Products Company	Low Pressure Coking	Vol 33, No 2, p 157 (February, 1954)


Combination
Fractionator
Gas
Gasoline
Gas Oil
START
M
Coke
Drums
Furnace



Fluid Coking—ESSO RESEARCH AND ENGINEERING COMPANY

Application—Fluid Coking is used to convert low-value crude oils and residual oils to more needed products—gasoline and home heating oil.

Charge—The process will handle atmospheric residua with initial boiling points as low as 600-700 F. or vacuum residua with initial points close to 1200 F. Feed stocks with gravities as low as 1.8° API and heavier or with Conradson Carbons as high as 35 percent have been processed. Indications are that any pumpable feed can be handled by this flexible process without much change in equipment.

Product—Normal products are naphtha, gas oil, coke and light gases. Clear research octane number of the debutanized coker naphtha is 75 to 80, and it can be treated for satisfactory stability. As a cracking stock, coker gas oil is slightly poorer than virgin gas oil.

Description—A unit consists essentially of a reaction vessel and a burner vessel. The feed stock is injected into a fluidized bed of coke particles in the reaction vessel. The temperature in this bed is uniform and may be in the range of 950 to 1050 F.

In the reactor the feed is almost completely converted into overhead vapor and coke; the latter deposits on the coke particles already there. The vapor products are taken overhead through a cyclone separator which removes entrained coke and returns it to the reaction zone. The overhead product then passes to conventional separation equipment and a small amount of recycle bottoms is returned to the reactor.

The heat for carrying out the coking is generated in the burner vessel. A stream of coke particles is transferred like a fluid through a standpipe-riser system to the burner vessel. Air is supplied to burn enough of the coke to provide the heat for the process. The hot coke carries heat back to the reactor, completing the continuous circuit. The net coke produced is withdrawn continuously to maintain the proper inventory in the system.

Yields—Typical yields from recycle Fluid Coking are as follows:

Feed: Vacuum residuum from West Texas crude 9° API, 18 percent Conradson Carbon

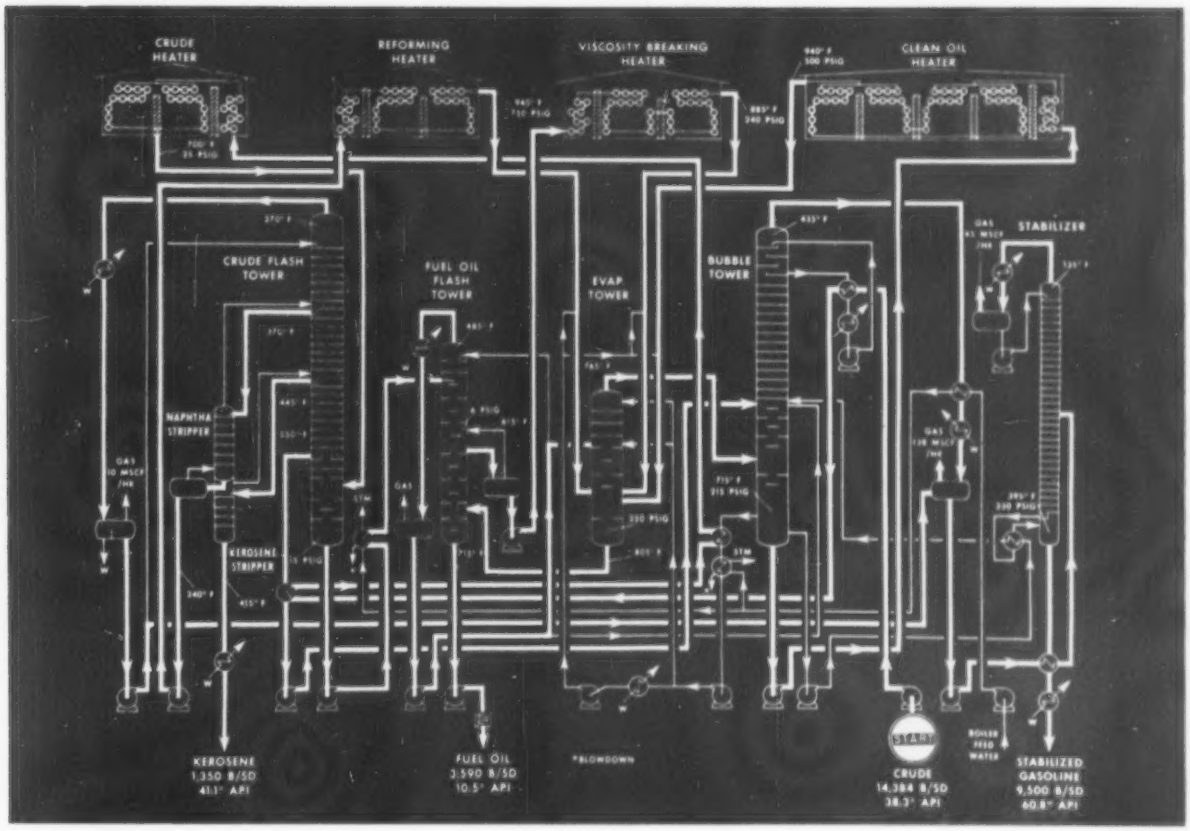
Dry Gas, Wt. percent	10
Naphtha, Vol. percent	26
Wide-cut Gas Oil. Vol. percent	55
Coke (Gross), Wt. percent	20

The proportions of naphtha and gas oil can be varied by adjusting operating conditions. The wide-cut gas oil (430/1015 F.) is available as catalytic cracking feed. If desired a home heating oil cut can be taken directly from this stream.

Reference—PETROLEUM REFINER, vol 33, no 11, p 157 (Nov, 1954).

COMMERCIAL FLUID COKING UNITS
(Operating, Building, or Approved)

COMPANY	Location	Capacity, B/SD	Date on Stream	Contractor
Carter Oil Co.	Billings, Mont.	3,800	December '54	Fluor
Esso Standard Oil Co.	Baltimore, Md.	10,000	September '55	Bechtel
Canadian Petrofina, Ltd.	Montreal, Quebec	3,800	(July '56)	Canadian Kellogg
Aurora Gasoline Co.	Detroit, Mich.	4,000	(July '56)	R. M. Parsons
Tidewater Oil Co.	Associated, Calif.	42,000	(January '57)	Bechtel
Tidewater Oil Co.	Delaware City, Del.	42,000	(January '57)	C. F. Braun
Bankline Oil Co.	Bakersfield, Calif.	4,000	(1st Q. '57)	Fluor
Pontiac Eastern Corp.	Hattiesburg, Miss.	4,800	(2nd Q. '57)	Fluor
Total		114,400		



Combination Cracking—THE LUMMUS COMPANY

Application—The process is applied to the segregation of cracking stocks and their independent selective cracking under optimum conditions.

Charge—Crude oil.

Product—Stabilized gasoline, fuel oil and kerosine.

Description—The accompanying process flow diagram is for a modern combination unit employing three cracking heaters, a crude heater, and a five tower fractionating system. This unit is designed to process 14,000 bpd of 38° API crude oil. The operating conditions for processing of this specific stock and the products obtained are shown on the diagram.

The crude charge is preheated to suitable temperature for distillation by heat exchange with cracking process streams and the crude heater. In the crude flash tower the kerosine is fractionated and the naphtha is removed for reforming. The topped crude less fuel oil is mildly cracked in a viscosity breaking step and the clean gas oil is thermally cracked.

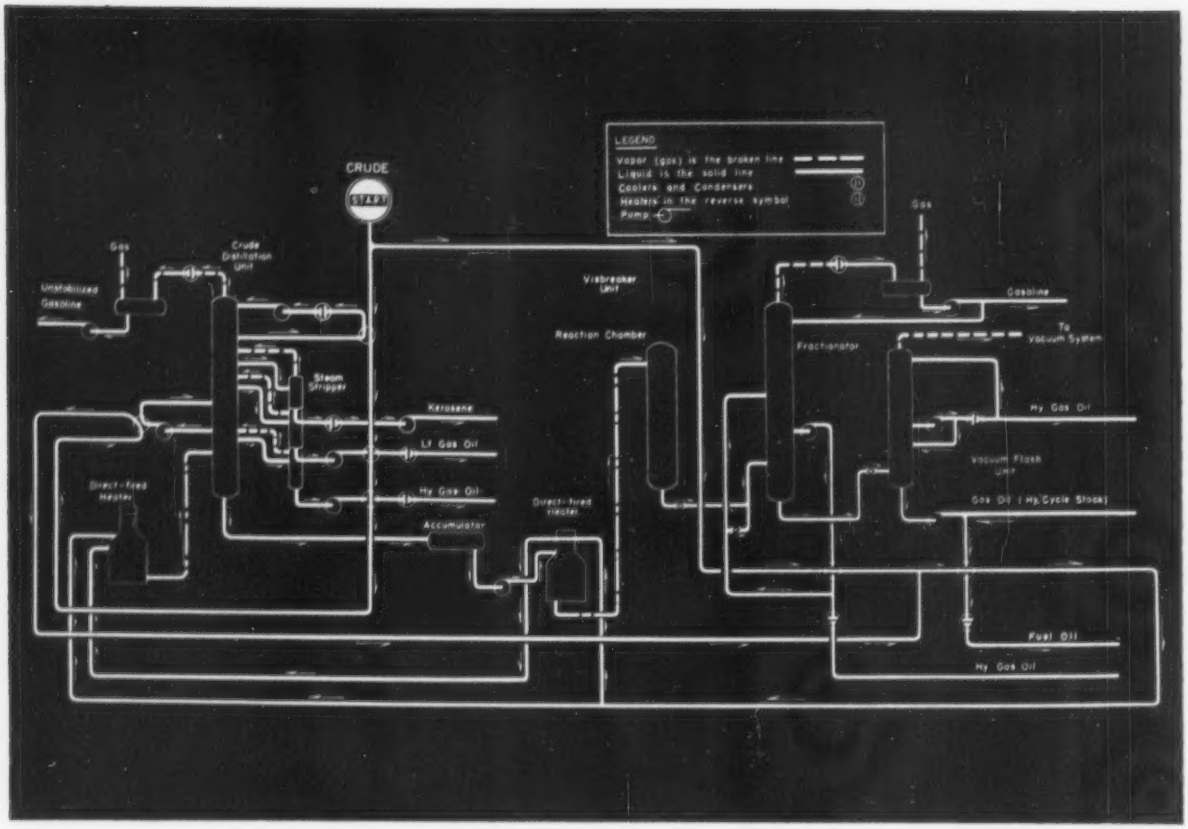
To design for optimum cracking conditions for each stock, independent control of the heating and soaking conditions must be provided. Hence cracking is made selective by employing several cracking coils, each having separately fired heating and soaking chambers in the furnace settings. Another factor which is considered in the heater design of these units to insure and provide an unusual degree of operating flexibility is a uniform rate of heat transfer which will maintain a satisfactory degree of temperature control resulting in minimum coke formation.

The flow sheet given shows one type of combination cracking. The design of such a unit varies with the specific needs of the refiner. However, each unit is basically designed for the segregation of cracking stocks and their independent selective cracking under optimum conditions. The segregation of cracking stocks is based according to both refractivity and boiling range. The selected stocks are cracked under closely controlled conditions in heaters of special design to obtain maximum conversion per pass larger yields and longer runs.

Modern development and improvement in catalytic cracking greatly reduced the application of thermal cracking processes in the refining of petroleum in the United States. However, it still remains an excellent balance tool in processing catalytic cycle stock and an excess of heavy oils into additional production of gasoline. In countries where there is no race for high octane number gasolines, the thermal cracking processes are still in demand, particularly for combination units with topping, vis-breaking and gas oil cracking.

To illustrate the versatility of units of this nature, during the initial run of a four coil unit it was possible to switch from one crude oil to another of a different type, without interrupting the run or making any off specification products.

Commercial Installations—Twelve.



Combination Unit—FOSTER WHEELER CORPORATION

Application—The Combination Unit combines the operations of crude distillation, visbreaking, and vacuum flashing. The visbreaking process reduces the viscosity and pour point of the ultimate fuel oil product and provides additional feed stock for catalytic cracking.

Charge—Crude oil to the distillation unit, reduced crude to the visbreaking unit, and visbreaker heavy residual bottoms to the vacuum flash unit.

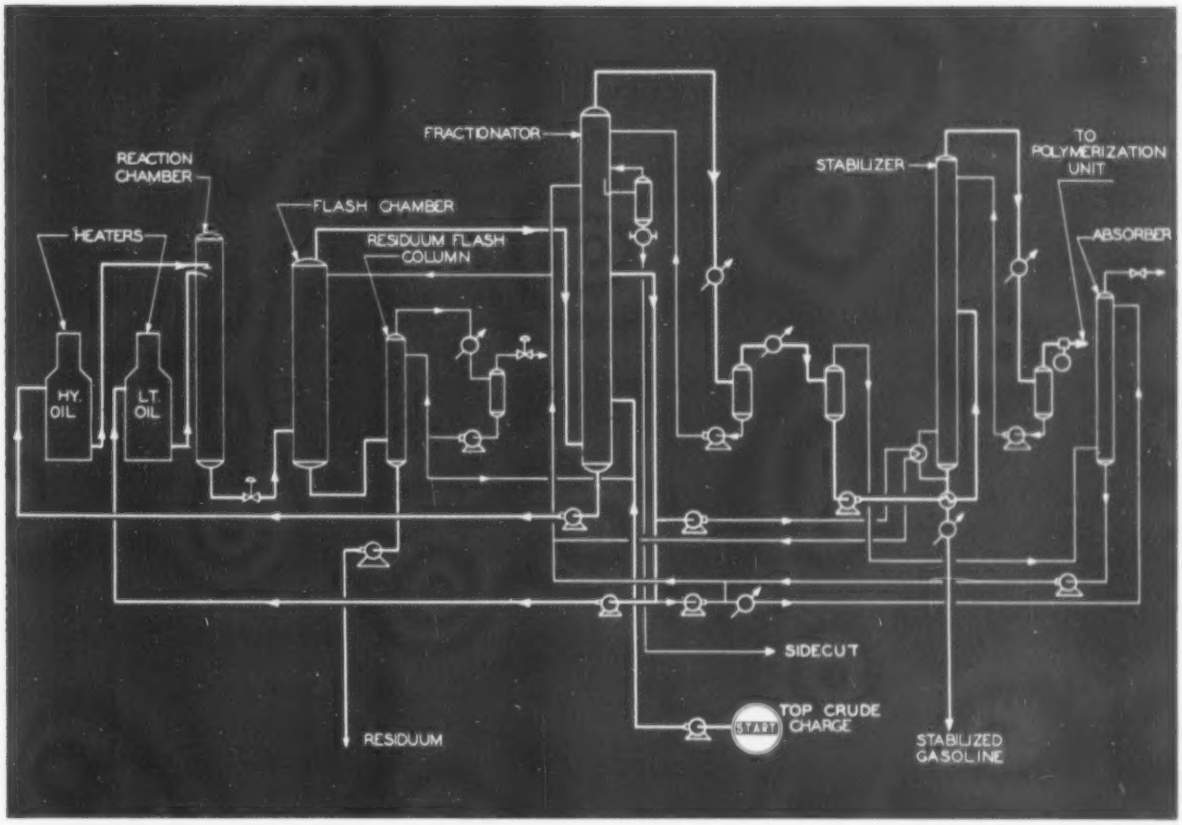
Products—From the crude unit, unstabilized gasoline, kerosine, light gas oil, heavy gas oil and reduced crude. From the visbreaking unit, gasoline, heavy gas oil, cracking stock, and a heavy residual as bottoms. From the vacuum flash unit, heavy gas oil and fuel oil.

Description—Referring to the flow diagram, the crude entering the combination unit is split into two streams. The first stream exchanges heat with the top-of-column pump-around of the crude distillation column. It then picks up additional heat by heat exchange with the light and heavy gas oil side streams from the crude distillation column. Further heat is added by heat exchange with the mid-pump-around of the crude distillation column. This crude stream then joins the other crude stream which has been preheated by exchange with the pump-around system of the visbreaker fractionator. The combined streams pick up more heat by heat exchange with the bottoms from the vacuum flash unit and then flow directly to the direct-fired heater of the crude distillation unit. Part of this combined stream passes through the convection section of the direct-fired heater of the visbreaker unit and then flows to a lower pressure position in the dircet-fired heater coil. The preheat temperature of the combined stream leaving the last heat exchanger is 495 F., while the temperature of the stream further preheated in the convection section is 640 F.

In the direct-fired heater of the crude distillation unit the crude is heated to a temperature of 725 F. and the liquid-vapor stream enters crude distillation column where it is separated into unstabilized gasoline as a top-of-column product, kerosine, light gas oil and heavy gas oil as side streams and reduced crude as the bottoms.

The reduced crude flows to an accumulator from which it is pumped into the direct-fired heater of the visbreaker unit. In this unit, under a pressure of 250 pounds, it is raised in temperature to 920 F., and then enters a reaction chamber where the cracking and visbreaking is completed. Leaving the bottom of this reaction chamber the combined liquid-vapor stream enters the visbreaker fractionator where it is separated into visbreakeer gasoline, heavy gas oil, cracking stock, and a heavy residual as bottoms. These bottoms then flow to the vacuum flash tower where, under an absolute pressure of 20 mm. Hg there is produced additional quantity of heavy gas oil to be used as feed stock for the fluid catalytic cracking unit. The bottoms from this vacuum flash tower are blended to fuel oil specifications with, for example, a heavy cycle stock, and pass through a cooler to storage.

This unit is now in operation at the Barrancabermeja, Colombia, refinery of Empresa Colombiana de Petroleos. The crude distillation unit has a capacity of 30,000 barrels per day, and the visbreaker 16,500 barrels per day.



Thermal Cracking—UNIVERSAL OIL PRODUCTS COMPANY

Application—The process produces gasoline from every variety of charging stock, from naphthas to the heaviest crudes and residual oils.

Thermal cracking produces butylenes and propylene which can be polymerized to produce polymer gasoline of high octane number for use as a blending fluid to improve the quality of other gasolines.

Description—The ideal equipment for thermally cracking topped or reduced crudes is centered about the two-coil cracking unit designed for optimum results when producing high-grade cracked fuel oil residuum.

The topped or reduced crude charge is introduced to the side of the fractionating column where it is contacted with the vapors from the flash chamber. The overhead product from the fractionating column is end point gasoline. Furnace or tractor distillates are withdrawn as sidecuts and stripped to specifications. From a lower sidecut tray a higher boiling distillate comprising the lower boiling fractions of both the recycle and charging stocks is withdrawn as charge to the light oil heater. The charge to the heavy oil heater is withdrawn from the bottom of the fractionating column, and consists of the highest boiling fractions of both the recycle and charging stocks.

The transfer lines from the two heaters enter the top of a downflow reaction chamber. This chamber is operated without a liquid level, since all of the products are withdrawn from the bottom through a pressure control valve.

The mixture leaving the reaction chamber enters the flash chamber in which a fuel oil residuum of the desired properties is separated.

Yields—To illustrate the comparative results obtained in various methods of processing, the following yields are presented as representative results when charging a typical 25° API Mid-Continent reduced crude having a viscosity of 20 SFS at 122 F. In considering these results, it must be remembered that not only the gravity but also the viscosity of the charge is important in determining yields.

	Maximum Gasoline	Maximum Furnace Oil
Percent by Volume of Charge:		
Gasoline, 400 E.P., 10 RVP	53.5	38
Furnace Distillate		23
Fuel Oil	37.5	34
Liquid Volume Loss	9	5
Gas, Cu. Ft./Barrel	500	290
Octane Number (ASTM)	69–70	68–69
Fuel Oil, Viscosity, SFS at 122 F	200	200
Fuel Oil, Gravity, °API	7	8
Percent Catalytic Polymer Gasoline, 10 RVP	5	3.5
Percent Total Gasoline, including Polymer	58.5	41.5
Octane Number of Total Gasoline	71–72	70–71

It should be noted that the cracked gasoline yields are all reported on the basis of 400 F. end point and 10 RVP. On the basis of total butane-butylene retention in the gasoline the yields would be increased approximately 4 percent respectively. The yields of catalytic polymer gasoline shown in the table are on the basis of polymerizing 80 percent of the propylene and butylenes formed in the cracking operation.

Alkylation

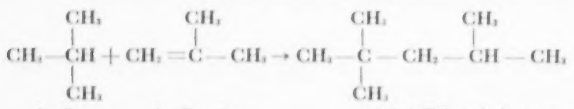
THE PRINCIPLE of alkylation as it applies to motor fuel production involves the combination of an *iso*-paraffin, usually *iso*-butane, with olefins such as propylene, butylene and amylene. The resulting product is a gasoline component with very desirable stability properties and high octanes.

Alkylate is an excellent aviation gasoline blending stock and may be 90-95 percent of a grade 115/145 aviation gasoline. During the war, all alkylate was committed to the production of aviation gasoline, but now more and more is finding its way into motor fuels.

The present capacity of alkylation in the U. S. is about 275,000 barrels per day. This is expected to grow an additional 5000 barrels daily before the end of the year, and by the end of 1957, the capacity is expected to total 300,000 barrels per day.

Most of the capacity today was installed because of the aviation gasoline demands created by war. With the coming of jet flight, it is predicted that there will be very little additional increase in aviation gasoline demand. Future alkylation capacity, then, will be available for motor fuel.

One of the reactions which occurs when alkylating *iso*-butane and *iso*-butylene may be represented as follows:



iso-Butane *iso*-Butylene 2,2,4-Trimethylpentane

There are many side-reactions and many different types of hydrocarbons are formed during alkylation. However, the predominate single component (30-50 percent of the total alkylate) is 2,2,4-trimethylpentane (*iso*-octane). This is true even when the olefin is *n*-butane indicating that isomerization occurs during the alkylation reaction.

The polymerization of olefins is an undesirable side-reaction which occurs. To minimize polymerization and thus increase octane rating of the alkylate, designs are incorporated to maintain the concentration of olefin very low relative to *iso*-butane. One means of doing this is to introduce the olefin at several points in the system to keep down local concentrations. Also, *iso*-butane is recycled in large quantities so that its local concentration will remain high.

The catalysts used commercially for alkylation are sulfuric acid, hydrofluoric acid, and aluminum chloride promoted with hydrochloric acid. The reaction may be achieved thermally; however, a pressure of 3000-8000 psig is required. On the other hand, if catalyst is used, much lower pressures may be employed. Sulfuric acid alkylation units, for instance, usually are operated at near atmospheric pressure.

Temperature is another important variable in alkylation. If the temperature is allowed to exceed 70 F. in sulfuric acid alkylation, oxidation of the hydrocarbons occurs to such an extent that acid consumption is increased. With hydrofluoric acid, higher temperatures are permitted, although better octane ratings are achieved at lower temperatures.

Some advances have been made in reducing the cost of the refrigeration that is associated with alkylation. Effluent refrigeration is one of these improvements. In some other cases, field butanes-butylenes may be routed through the alkylation unit. Here, their flashing furnishes the refrigeration for the system. The vapors may then be passed on to the existing refinery gas recovery system. Thus only incremental work is required from the gas recovery compressors to furnish the energy of refrigeration.

Alkylation products usually are treated to remove acid compounds. If left in the stream, the compounds break down later in the gas recovery system and cause undue corrosion problems. Some methods use bauxite treaters to remove the acidic compounds. Others add basic materials, such as ammonia, for neutralization of the acids.

Alkylation is second to reforming as a means of getting economical octanes. The alkylate will have an F-1 octane rating of around 95 unleaded. Its outstanding characteristic, however, is its relatively high F-2 rating—about 92. This quality is very desirable to compensate partially for the high sensitivity imparted to a gasoline blend by reformed and cracked components.

The new interest in F-2 ratings of motor fuels is generated by some recent trends in automobile engine designs. As the compression of an engine is increased to achieve more power, the engine has a greater tendency to knock at high speeds. The F-2 rating of a fuel is a measure of its ability to satisfy high-speed octane requirements of an engine. Therefore, the refiner desires that some gasoline components have a high F-2.

Other applications of alkylation, besides production of a gasoline blending component, are production of petrochemicals. Ethyl benzene is an example of such a petrochemical. It is produced by combining benzene with ethylene. The product is used in the formation of styrene and synthetic rubber. More details of these applications are covered in the Petrochemical Handbook which was published in the December issue of the PETROLEUM REFINER for 1955.

Isomerization

HERE IS A newcomer to the refining limelight—isomerization. The process involves rearrangement of straight-chained hydrocarbons to form branched-chained products.

Isomerization was ushered into the refining field to furnish feed for alkylation, since alkylation can often consume more *iso*-butane than occurs naturally in refinery streams. For instance, here is a typical analysis of a C_4 fraction from a reforming operation:

Component	Wt. %
iso-Butylene	20
n-Butylenes	27
iso-Butane	18
n-Butane	35
Total	100

In an alkylation reaction the 47 percent total olefins are capable of uniting with far more *iso*-butane than is furnished by the 18 percent concentration. It would be desirable, then, to convert the *n*-butane, which normally is discarded from alkylation, by isomerizing it to *iso*-butane. Many isomerization processes are used for this purpose.

But now, isomerization is being called upon to add its bit to the octane race. It is easy to understand the possibilities for this proecss when octanes of some hydrocarbons are compared with octanes of their isomers. A comparison of C_5 and C_6 hydrocarbons is given in the following table:

Compound	F-1 Octane Number Clear	F-1 Octane Number + 3 cc TEL
n-Pentane	61.7	85.0
iso-Pentane	92.3	103.5
n-Hexane	24.8	65.3
Hexane Isomers		
2-Methylpentane	73.4	93.1
3-Methylpentane	74.5	93.5
2,2-Dimethylbutane	91.8	104.3
2,3-Dimethylbutane	102.6	107.8

This shows rather vividly the improvement that would accrue from the isomerization of *n*-pentane or *n*-hexane.

The reaction which occurs during isomerization may be represented by the following symbols:

$$\underset{n\text{-Pentane}}{CH_3-CH_2-CH_2-CH_2-CH_3} \rightarrow \underset{iso\text{-Pentane}}{CH_3-\overset{\displaystyle CH_3}{\overset{|}{CH}}-CH_2-CH_3}$$

The reaction is carried out in a hydrogen atmosphere in order to hydrogenate any slight amount of cracked materials which may be formed as side-reactions to the process. The isomerization reaction neither consumes nor produces hydrogen.

Two new isomerization processes have been announced within the last six months. These are Penex and Pentafining. For both processes, the catalyst contains platinum. The reaction is carried out in a hydrogen atmosphere, and any product that is not isomerized is recycled through the system.

Polymerization

THE PROCESSES, which are used in the industry to make greater quantity and higher quality gasoline, also produce large quantities of gaseous materials. The shift from thermal cracking to a catalytic process is accompanied by the production of gases. Likewise, reforming has this same drawback of breaking down some of the charge material into butanes and lighter. For this reason, polymerization adds to the over-all economy of a refinery.

Polymerization combines unsaturated materials to yield a product having a higher molecular weight than the feed. Thus, a hydrocarbon like propylene may be polymerized to a material boiling in the gasoline range.

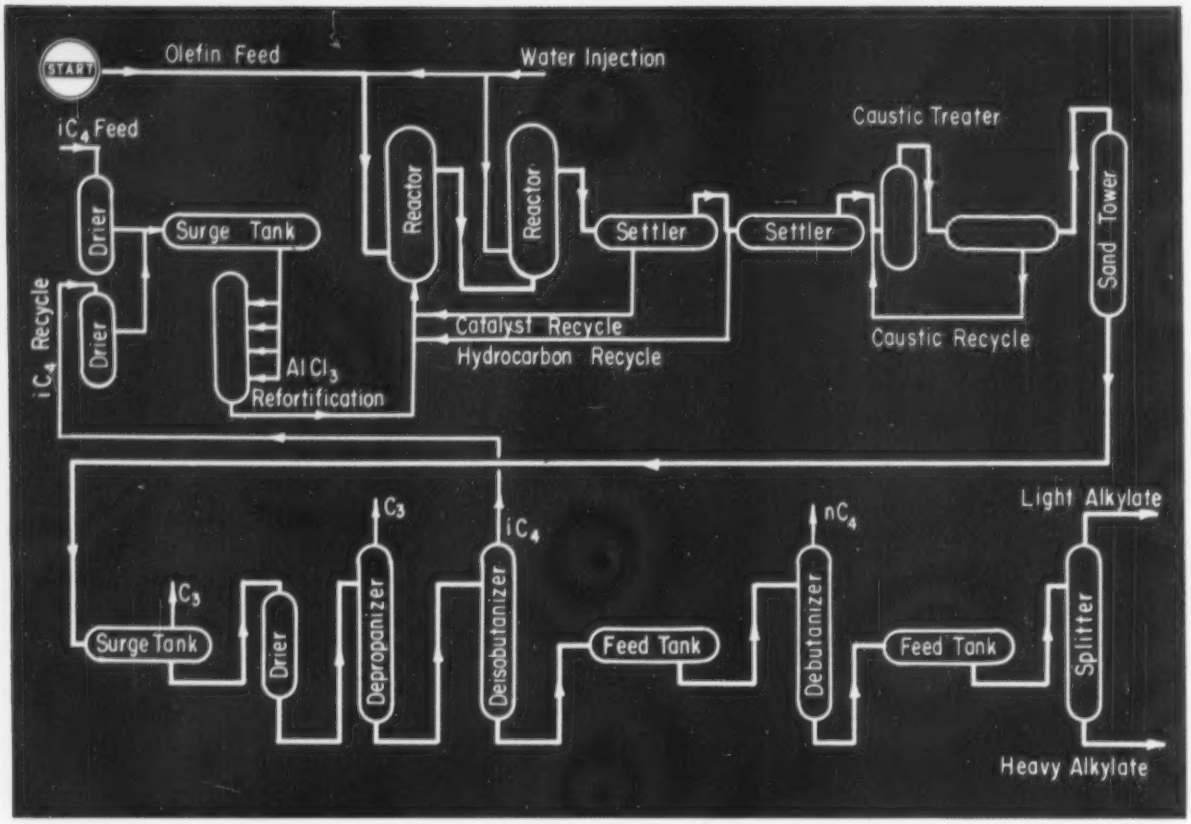
At first, the main objective of polymerization was only to increase the yield of gasoline. Therefore, no attention was given to selective polymerization. Now ethylene figures prominently in the preparation of many petrochemicals and is not normally polymerized for gasoline production. The process deals primarily, then, with the combination of propylenes and butylenes. If the refinery is very large, even the butylenes will not be polymerized, since they will be fed to an alkylation unit.

Polymerization capacity now is about 142,000 barrels per day. It is the third most desirable processing technique in the refinery—the first two being crude preparation (topping) and some form of cracking. With the present heavy growth in reforming capacity, polymerization is necessary to utilize properly the light olefins produced as by-products from reforming operations.

As for octanes, polymer gasoline has an F-1 rating of 95-97 unleaded and exhibits about the same lead susceptibility as catalytically cracked gasoline. Its sensitivity (12-14 octane numbers) is a little greater than cracked stocks.

Polymerization is not strictly an octane improving process, since it is used in the refinery to make gasoline blending components from materials which are not in the gasoline boiling range. The process' growth, then, does not parallel the present rapid growth in reforming, nor the trend to greater growth shown by alkylation. It, nevertheless, is important in the over-all refinery economy and is beginning to take a greater role in petrochemicals.

Even now, the high molecular weight olefins from polymerization furnish raw materials for detergent production. When olefins are polymerized for this purpose, the lower molecular weight materials are recycled to achieve greater yields. Polymerization also furnishes raw material for some Oxo processes in which the olefins are converted into industrial alcohols and aldehydes.



Aluminum Chloride Alkylation—PHILLIPS PETROLEUM COMPANY

Application—Aluminum chloride alkylation is a liquid phase catalytic process for conversion of normally gaseous hydrocarbons to high octane motor fuel.

Charge—The process involves the basic reaction of ethylene and propylene with isobutane to produce a high quality product boiling in the gasoline range.

Description—Dry fresh feed, consisting of ethylene, propylene and isobutane, is charged to a stirred reactor. Intermittent addition of catalyst to the system is accomplished by passing the isobutane charge through a catalyst make up drum. The reactor effluent passes through a primary settler for phase separation of hydrocarbon and catalyst. The catalyst is recirculated to the primary reactor.

A major portion of the effluent from the primary settler is recycled through a cooler to the first reactor for control of efflulent temperature from the second reactor in the range of 120 F. The reactors normally operate with a 3 degree rise in temperature.

The remaining portion of hydrocarbon from the primary settler passes to a second settler for final removal of any entrained catalyst then to a caustic washer before entering the fractionation section.

Catalyst employed is aluminum chloride existing as a hydrocarbon complex. HCl is an active promoter of catalyst activity and is produced by injecting a controlled amount of water into reactors.

Propane and lighter hydrocarbons are yielded as an overhead gas from a depropanizer, isobutane is yielded overhead from a deisobutanizer and recycled to the reactors. The bottom product from the deisobutanizer is fractionated for end point control in an alkylate splitter.

Typical process data are summarized in the following tabulation:

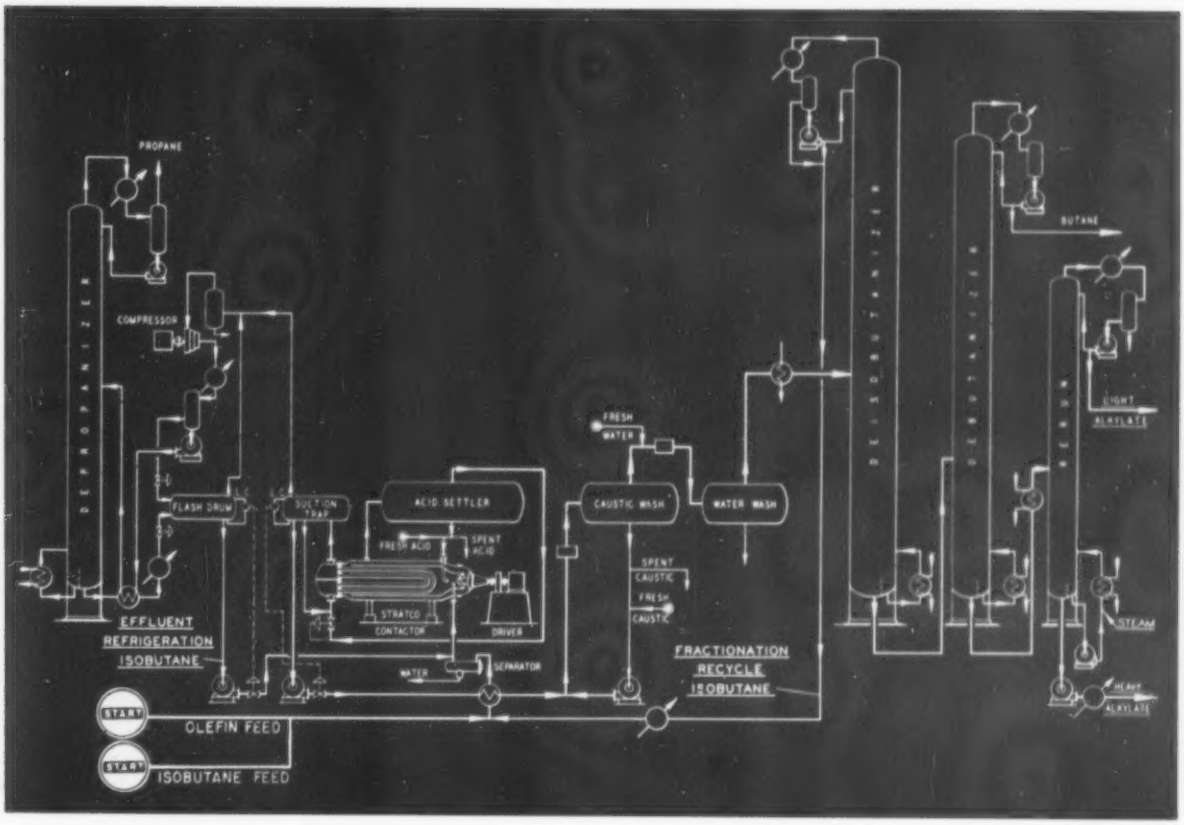
Feed Components, Mol %	
Methane	12.5
Ethylene	45.2
Ethane	15.8
Propylene	23.2
Propane	2.7
Butane	0.7
Total	100.0
Motor Alkylate Properties	
Percent of total alkylate	95.0
R.v.p. (undebutanized)	9.0
°A.P.I.	74.0
A.S.T.M. distillation, °F.	
I.b.p.	110
10 percent	129
20 percent	140
50 percent	159
90 percent	300
95 percent	363
E.p.	425
A.S.T.M. research octane number:	
Clear, 0 ml. TEL	59.1
1 ml. TEL	*102.7
3 ml. TEL	†109.5

* Equivalent of A.S.T.M. research method rating of 0.15 ml. TEL in isooctane.

† Equivalent of A.S.T.M. research method rating of 1.10 ml. TEL in isooctane.

Economics—Representative cost data are given in the following table.

Utilities	Unit/Bbl. Total Alkylate
Steam (million Btu absorbed)	0.44
Cooling-water circulation, 1000 gal., 20° rise	2.6
Makeup water, 1000 gal.	0.08
Power, kw.-hr.	3.3
Chemicals	
Caustic, lb.	0.015
Aluminum chloride, lb.	2.80



Effluent Refrigeration Alkylation—STRATFORD ENGINEERING CORPORATION

Application—The process combines propylene, butylenes, and amylenes with isobutane in the presence of strong sulfuric acid to produce high octane branched chain hydrocarbons (alkylate) for use in aviation gasoline and motor fuel. Effluent Refrigeration is essentially a means of obtaining economically a very high concentration of isobutane in the reaction mixture with little conventional isobutane fractionation. It may be applied to new plants, or to existing alkylation plants, for the production of higher quality alkylate or for increased production.

Product—Most of the currently operating plants are processing butylenes and all are producing debutanized total alkylates having end points well under 400 F. These total alkylates have CFRR octane ratings clear of 94-97, and well above 100 with 3 cc of TEL. Their F-1 blending values with 3 cc TEL and refinery blending stocks such as reformates and catalytic cracked naphtha are also well above 100. The alkylates may be rerun to produce 96-98 percent of 338 F.E.P. aviation alkylates which have 3-C performance numbers with 4.6 cc TEL of 155-165.

Description—The feed streams along with a recycle stream of sulfuric acid are charged to the Stratco contactor. The acid-hydrocarbon mixture is circulated at a high rate so that the isobutane to olefin ratio at the point of olefin injection is usually in the range of 400:1 to 800:1. The acid-hydrocarbon mixture leaving the contactor is passed to the settler where it is separated into an acid phase which is returned to the contactor and a hydrocarbon phase which leaves the top of the settler. The hydrocarbon effluent passes a back pressure regulator, is reduced in pressure, and is thereby self cooled by partial vaporization of its isobutane component. The resulting cooled effluent is routed through the cooling coils within the contactor.

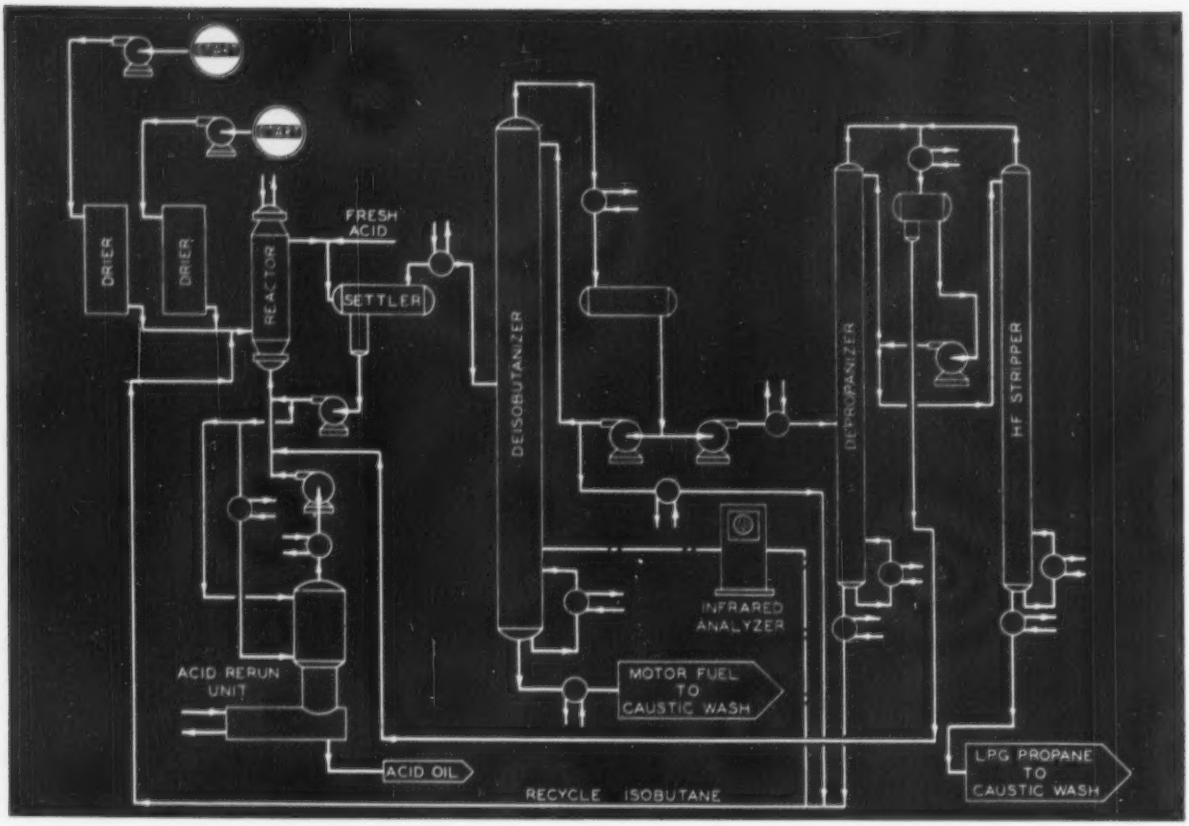
The vapors, which are largely isobutane, are disengaged from the liquid in the suction trap, passed through the compressor or a closed cycle refrigeration unit, and condensed. After depropanization and cooling by flash vaporization, the "effluent refrigerant" is returned to the contactor.

The overhead from the deisobutanizer and the effluent refrigerant recycle together constitute the total isobutane recycle to the reaction zone. Plants currently being designed call for about 1.2 parts of isobutane in the fresh feed, 2.5 to 3.0 parts from the deisobutanizer, and 5 to 6 parts from the effluent refrigeration recycle, for each part of olefin in the fresh feed. This gives an isobutane to olefin ratio of 8.7:1 to 10.2:1 in the feed to the reactor. Usually 60-70 percent of the external isobutane recycle comes from the effluent refrigeration recycle and only 30-40 percent from the deisobutanizer. No portion of this isobutane recycle is permitted to vaporize in the reactor. The total increased quantity of isobutane is present in liquid phase throughout the entire reaction zone, thereby serving to promote the alkylation reaction to the same extent as equivalent isobutane from a deisobutanizer. Isobutane concentration in the hydrocarbon phase leaving the reactor normally ranges between 60 and 70 volume percent.

The bottoms from the deisobutanizer are debutanized and the resulting total alkylate may be rerun to the proper endpoint. However, the alkylates produced by effluent refrigeration have an endpoint well under 400 F. so that if the alkylate is to be used in motor fuel, it need not be rerun.

Commercial Installations—Seven commercial plants employing effluent refrigeration are now in operation, six are under construction, and a considerable number are in the design stage.

Reference—Petroleum Refiner, vol 34, no 9, p 148 (Sept, 1955).



Perco HF Alkylation—PHILLIPS PETROLEUM COMPANY

Application—The commercial use of hydrofluoric acid as a catalyst for the alkylation of olefins with isobutane is a well-established process for the production of high-octane, high-blending-value components in aviation gasoline and motor fuels.

Charge—The charge to the Perco HF alkylation unit is a bauxite-dried liquid feed containing isobutane and olefins, such as propylene, butylenes, and amylenes.

Product—The HF alkylation process gives a high yield of motor fuel blending component from olefin charged to the unit.

Description—The essential features of the HF alkylation process process shown schematically in the flow diagram are arranged for the production of motor fuel alkylate. The liquid olefin and isobutane feed streams are passed through separate driers then into the lower section of the reactor. The liquid hydrofluoric acid enters the reactor through a recycle line connected to the bottom of the reactor. The alkylation reaction is completed by intimate contacting, after which the hydrocarbon and the recycle acid flow to a settler where a two-phase separation occurs. The hydrocarbon phase is charged to the fractionation section where the recycle isobutane is separated from motor fuel alkylate. A small portion of the acid phase from the settler flows to an acid rerun unit where the hydrofluoric acid catalyst is continuously purified by fractionation. The remainder of the acid from the settler is recycled to the reactor.

Perco HF alkylation units may be designed for either water-cooling or refrigeration of the reactor effluent, the latter resulting in improved product quality. An excess of isobutane is recycled to the reactor for the purpose of product quality control. For motor fuel production the optimum ratio of external isobutane to olefin is in the range of 5:1 to 7:1.

Operating Conditions—On-stream factors are in the range of 98 percent and for periods of 18 to 24 months between turnarounds. Typical data are given in the following table.

TYPICAL OPERATION OF HF ALKYLATION
(Based on 100 bbl. per day total feed)

Charge to Unit:	Bbl.
C_4 fraction from cat. cracker:	
Propane	0.9
Propylene	0.9
Butylenes	32.5
Isobutane	40.2
n-Butane	25.5
Total unit feed	100.0
Yields From Unit:	
Propane	0.9
Isobutane	1.1
n-Butane	25.5
Alkylate	56.8
Total yield	84.4

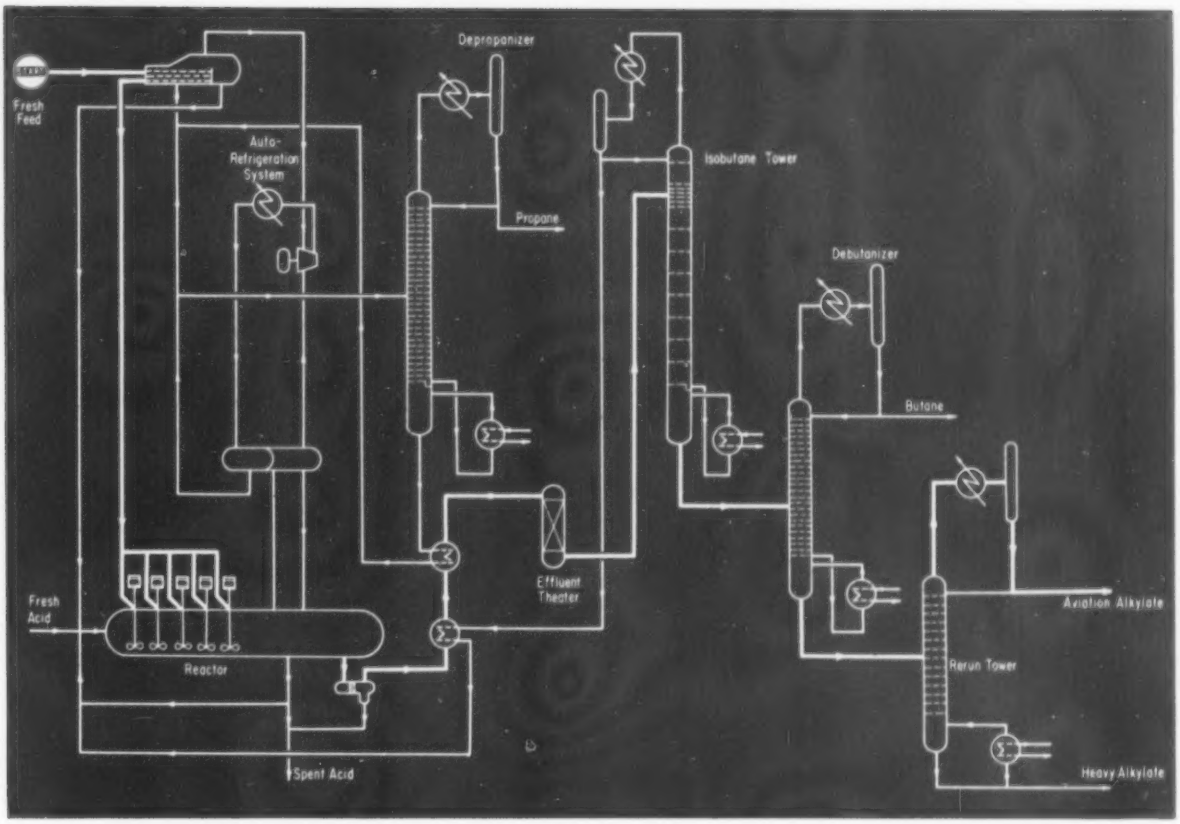
TYPICAL PROPERTIES, DEBUTANIZED MOTOR-FUEL ALKYLATE

Gravity, °A.P.I.	68.8
ASTM distillation, F.:	
I.b.p.	160
50 percent evap.	224
End point	392
ASTM Research Octane Number:	
+0 ml. TEL	93.1
+1 ml. TEL	100.8
+3 ml. TEL	104.9

Economics—A summary of the direct operating expense for a 98 percent stream factor is given in the following table.

	Dollars per Bbl. Alky.
Operating Labor	0.0800
Supervision and Laboratory	0.0800
Repair Labor and Materials	0.1600
Utilities	0.1596
Chemicals	0.0660
Total	0.5456

Reference—Petroleum Refiner, vol 34, no 9, p 126 (Sept, 1955).



Sulfuric Acid Alkylation—THE M. W. KELLOGG COMPANY

Application—The process is applied to the production of alkylate as a high-octane isoparaffin component of aviation and motor gasoline.

Charge—Light olefinic hydrocarbons, such as propylenes, butylenes and pentenes, with isobutane either individually or as mixtures.

Product—The octane rating of the alkylate ranges from 88 to 97 CFR-R clear or 130 to 162 F-4 with 4.6cc TEL, depending on the types of feed.

Description—In Cascade alkylation units, the olefin-bearing liquid feed is cooled to about 35 to 45 F. and contacted with an excess of isobutane in the presence of sulfuric acid catalyst. The olefin feed is split into parallel streams and charged to each reaction zone of the Cascade system. Isobutane-rich recycle and refrigerant are introduced into the first reaction zone only, and pass in series through successive zones to provide the necessary excess isobutane. Series flow of isobutane recycle and acid catalyst with parallel flow of olefin feed is a novel design feature of the Kellogg Cascade reactor. In this manner the entire isobutane recycle stream plus the isobutane-rich refrigerant stream is contacted with only a fraction of the olefin feed stream in each reaction compartment. This arrangement creates a higher isobutane concentraton and a higher isobutane-olefin ratio in each stage than is possible in single stage contactors, thereby establishing optimum conditions for maximum production of high quality alkylate with a minimum quantity of isobutane recycle.

Reaction products, excess isobutane, and inert components of the feed are separated from the acid catalyst in the settling zone and charged to fractionation equipment for separation of isobutane recycle. Normal butane which does not take part in the reaction is then fractionated from the alkylate product. The heavy polymers produced are separated from the desirable alkylate in the rerun tower; isobutane recycle is returned to the first reaction zone of the reactor, and normal butane is withdrawn to product storage.

Vapor resulting from the removal of the exothermic heat of reaction is compressed, condensed and the liquid returned to the reactor as refrigerant. This stream is predominantly isobutane; however, its propane content is higher than elsewhere in the process. A portion is therefore diverted to a depropanizer tower for removal of propane from the system.

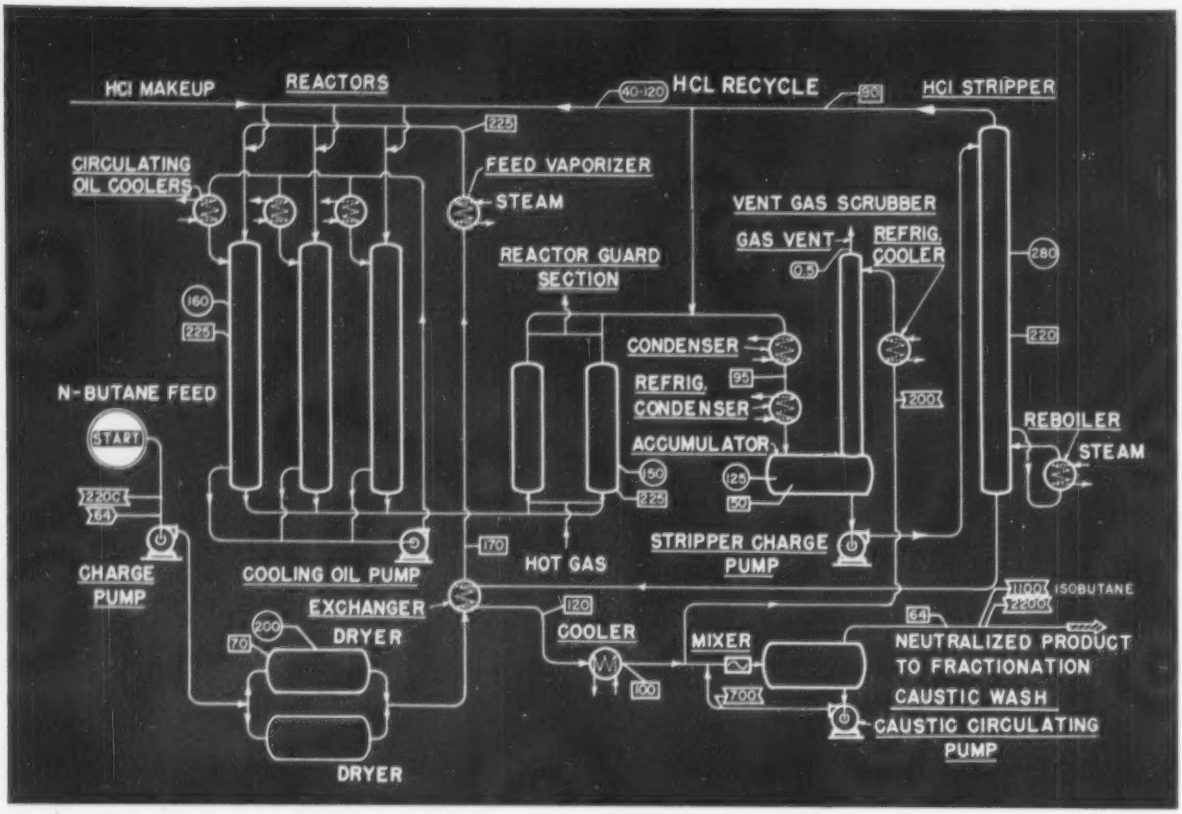
Sulfuric acid catalyst is recirculated through the reactor to maintain acid concentration and, as contaminants build up, a portion is withdrawn and replaced by fresh acid.

Acidic material entrained in the effluent hydrocarbons is removed by an effluent treater.

Operating Conditions—The major factors affecting product quality and yield are isobutane concentration, isobutane to olefin ratio, acid to olefin ratio, acid strength, and reaction temperature. Good dispersion of the hydrocarbon phase in the acid phase is extremely important. Product quality, acid consumption, and yield of 338 F. end point alkylate are directly proportional to the above operating factors. The higher the isobutane concentration, isobutane to olefin ratio, acid to olefin ratio and acid strength and the lower the reaction temperature, the higher the octane rating of the 338 F. end point material and the lower the acid consumpion and quantity of heavy polymer formed.

TYPICAL ALKYLATION YIELD DATA

Olefin Feed Type—	Propylene	40% C_3-60% C_4-	Butylenes	Pentenes
Yield—Bbl. Alkylate per bbl. olefin	1.78	1.74	1.72	1.60
Isobutane Consumption Bbl. iC_4 per Bbl. Olefin	1.275	1.174	1.106	0.965
Acid Consumption (Avge.): Lbs. 98% H_2SO_4 per Gal. Total Alkylate	2.5-0.84	1.5-0.6	0.84-0.33	1.0-0.4
338 F End Point Alkylate Quality:				
F-1 Research Octane No., Clear	89-92	92-95	94-97	90-93
+ 3.0 cc TEL	101.5-103.0	103.5-105.0	104.2-106.3	103-103.6
F-2 ASTM Octane No., Clear	87-90	90-93	92-94	90-92
F-3 or 1-C Performance No., 4.6 cc TEL	117-122	124-127	127-132	116-123
F-4 or 3-C Performance No., 4.6 cc TEL	129-142	141.6-154	150-162	136-148



Butane Vapor-Phase Isomerization—SHELL DEVELOPMENT COMPANY

Application—The process is applied to the isomerization of butane to isobutane.

Description—The process consists of passing normal butane vapor, at a moderate temperature, through a reactor or bank of reactors packed with a granular catalyst containing aluminum chloride. Dry hydrogen chloride gas is incorporated with the butane vapors to act as a catalyst promoter. The reactors may each consist of a single catalyst bed, or may be of a heat-exchanger type with the catalyst placed in tubes surrounded by circulating cooling liquid.

In typical plants the hydrocarbon charge is first pumped through a regenerative drying unit. It is then completely vaporized before it enters the reactors, together with a measured amount of hydrogen chloride recycle gas. The reactor effluent flows to a receiver through a cooler and a refrigerated condenser which condenses all the butanes, the hydrogen chloride going into solution. A small amount of uncondensable gas is vented from the receiver after being scrubbed with product recycle to recover hydrogen chloride. The condensate is charged to an HCl stripping column which effects substantially complete removal of recycle hydrogen chloride gas. Butanes, essentially free of hydrogen chloride, flow from the base of the column, while vapors, consisting largely of hydrogen chloride, are recycled to the reactors. Traces of hydrogen chloride in the isomerized product are removed by caustic scrubbing. The catalyst is resistant to poison, but it is necessary to reduce the proportion of olefins and pentanes in the charge stock to a low figure, since both of these produce objectionable by-products and tend to shorten the life of the catalyst.

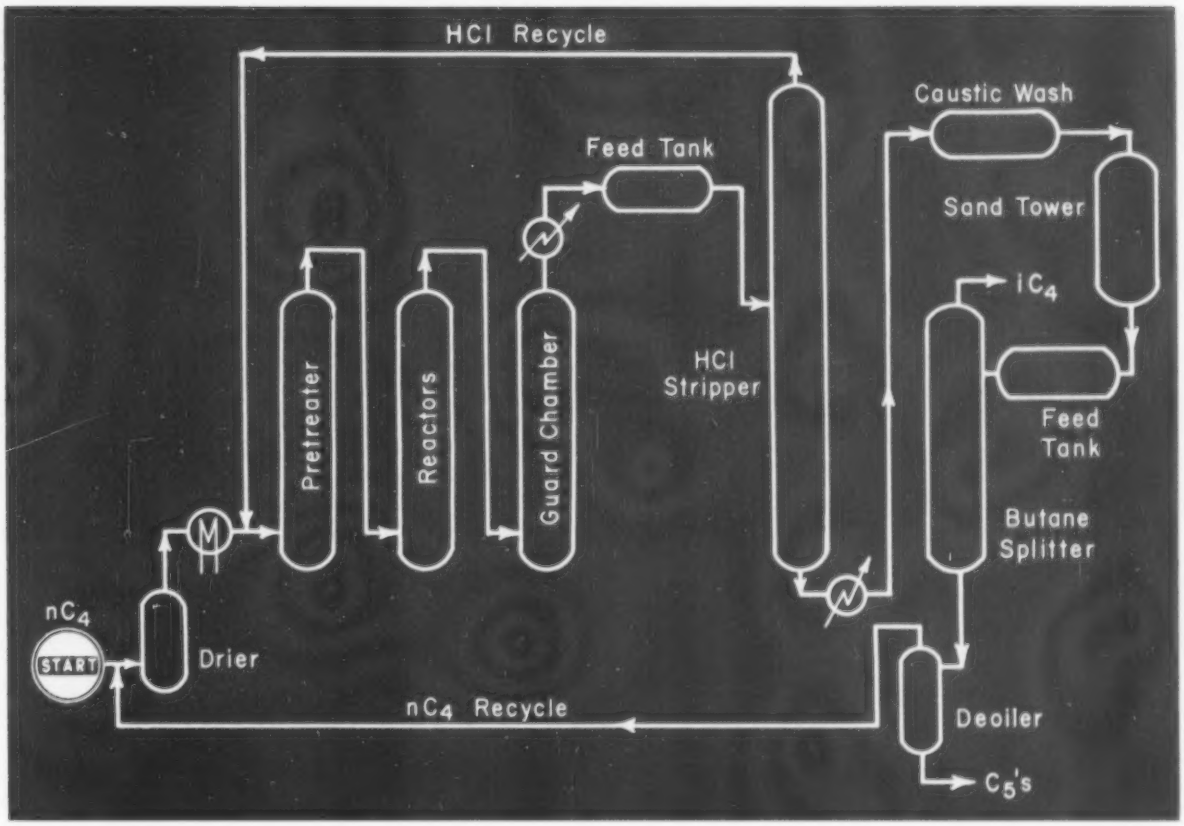
Operating Conditions—The table illustrates typical operating data.

	Plant 1	Plant 2
Normal butane charge to reactor, Bbl./Day	3510	1720
Isobutane in product, volume percent	47.6	42.2
Reactor inlet temperature, °F	253	213
Reactor pressure, lbs./sq. in. gauge	262	163
Hydrogen chloride in reactor feed, mole percent	16.8	11.6
Catalyst consumption, lb./day	3180	1120
Alumina ($AlCl_3$ absorber) consumption, lb./day	779	684
Hydrogen chloride consumption, lb./day	†	91
Isobutane produced, gal./lb. catalyst	24.0	27.1
On stream time, percent	96.7	91.7
Space velocity in catalyst bed, liq. vol./vol./hr*	1.01	0.84
Space velocity in $AlCl_3$ absorber, liq. vol./vol./hr.*	1.50	1.83

* Based on plant feed.
† Quantitative figures unavailable.

Commercial Installations—Nine units as follows:

Shell Oil Company, Inc., Houston
The Texas Company, Port Arthur, Texas
The Texas Company, Lockport, Ill.
Richfield Oil Company, Watson, Calif.
Tide Water Associated Oil Company, Avon, Calif.
Union Oil Company, Wilmington, Calif.
Sinclair Refining Company, Sinclair, Wyo.
Trinidad Leaseholds, Ltd., Trinidad, B.W.I.
Curacaosche Petroleum Ind. Mij., Curacao, N.W.I.



Catalytic Isomerization—PHILLIPS PETROLEUM COMPANY

Application—Isomerization of normal butane to produce a high-yield, high-purity isobutane is performed by a vapor phase catalytic treatment of dry normal butane wherein the catalyst utilized is aluminum chloride promoted with HCl.

Description—The dry normal butane feedstock is first vaporized and superheated and then, after being mixed with recycle HCl vapors, is fed to a pretreater. The pretreated feed next passes to the reactor.

The pretreater and reactor are bed type chambers containing aluminum chloride sublimed on bauxite. The reactor effluent, consisting of isobutane, normal butane and trace side reaction products, passes through a bauxite-filled guard chamber and then is condensed in a series of effluent exchangers. Removal of trace noncondensables from the liquid effluent stream is performed in a vent gas absorber and HCl vapor is removed by stripping. HCl vapor overhead from the stripper is recycled to the feed pretreater.

The bottoms product from the stripper passes through a caustic washer and sand filter before being charged to the fractionation section which consists of a deisobutanizer and a deoiler tower. High purity isobutane is yielded as an overhead product from the deisobutanizer. The normal butane overhead product from the deoiler is recycled to the driers. A small quantity of pentane and heavier production is yielded as a bottom product of the deoiler tower.

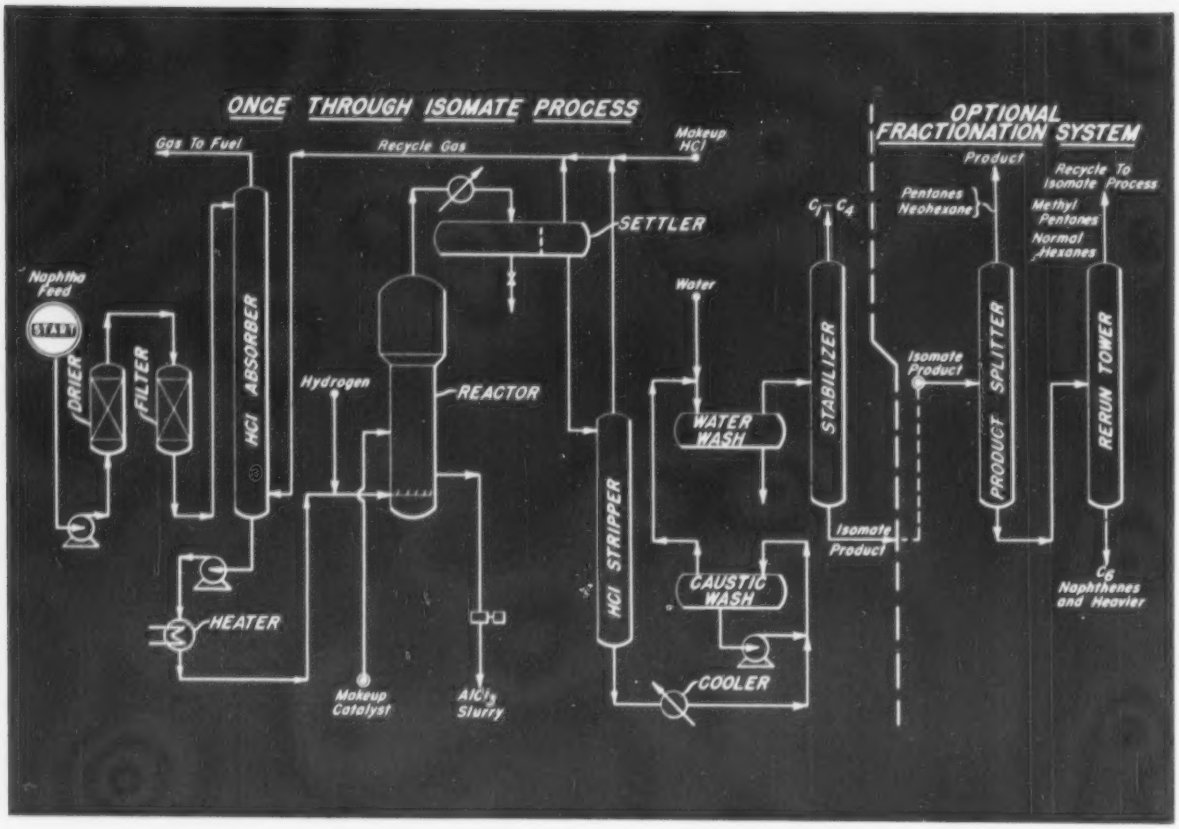
Addition of catalyst to the system is accomplished by subliming aluminum chloride with the hot feedstock and depositing it on the bauxite in the pretreater and the reactor. Make up HCl is injected into the system down stream of the effluent exchangers.

Yields—Typical process information is presented in the following tabulations:

Basis: 100 barrels of charge—50 percent conversion per pass.

	Charge (Bbl.)	Isobutane Yield (Bbl.)	Deoiler Bottoms (Bbl.)	Vent Gas (s.c.f.)
Ethane and Lighter	.....	.....	.....	Trace
Propane	.....	5	.....	.....
Isobutane	2	85	.....	.....
Normal butane	96	2	.....	.....
Pentane plus	2	.....	8	.....
	100	92	8	.....

	Unit/Bbl. Isobutane Produced
Utilities:	
Water circulation, 1,000 gallons	1.5
Water Makeup, 1,000 gallons	0.045
Power, kw.-hr.	1.54
Steam, 1,000 lb.	0.680
	Lb./1,000 Bbl. iC_4 Produced
Chemicals:	
Aluminum chloride	85
HCl	70
Bauxite	440
Driocel for driers	7
Caustic	89



Isomate—STANDARD OIL COMPANY (INDIANA)

Application—The Isomate process increases the octane number of light virgin naphtha by isomerizing low-octane paraffins to high-octane, branched isomers. The process complements catalytic reforming by upgrading C_5 and C_6 fractions which are difficult to reform.

Charge—The process is especially suited to processing hexanes and mixed pentane-hexane feeds.

Product—The octane number of Isomate product depends on whether once-through or recycle operation is employed. Leaded, Research octane numbers ranging from 95 to 106 (G.M. Extension Scale) are obtained. The product is an excellent blending stock because Research octane numbers correspond closely with motor and road ratings.

Description—The process may be designed for once-through operation (shown to the left of the vertical broken line) or product fractionation with recycle may be added if even higher octane-number products are required. The catalyst is an aluminum chloride-hydrocarbon complex promoted with anhydrous hydrogen chloride. Hydrogen gas is supplied to the reaction zone to suppress cracking and disproportionation and to maintain catalyst activity.

Dry feed, after picking up HCl gas in an absorber, is mixed with hydrogen and is introduced near the bottom of a tower reactor. Catalyst is added separately. Isomerization takes place in the liquid phase. Product goes overhead to a settler where hydrogen and some HCl are flashed and any entrained catalyst is separated. The product is then stripped of HCl, cooled, washed and stabilized. Gases from the settler and from the stripper are returned to the absorber for HCl recovery. In once-through operation, the stabilized produt is blended directly into gasoline.

If product having a leaded, octane number above about 97 is desired, the stabilized Isomate product is fractionated to separate high-octane neohexane, diisopropyl and pentanes as overhead; the lower-octane bottoms are rerun in a separate tower and recycled for further isomerization.

Operating Conditions—The Isomate Process employs reaction temperatures of about 240-250 F. Hydrogen is added to obtain a total reaction pressure of about 700-800 psi.

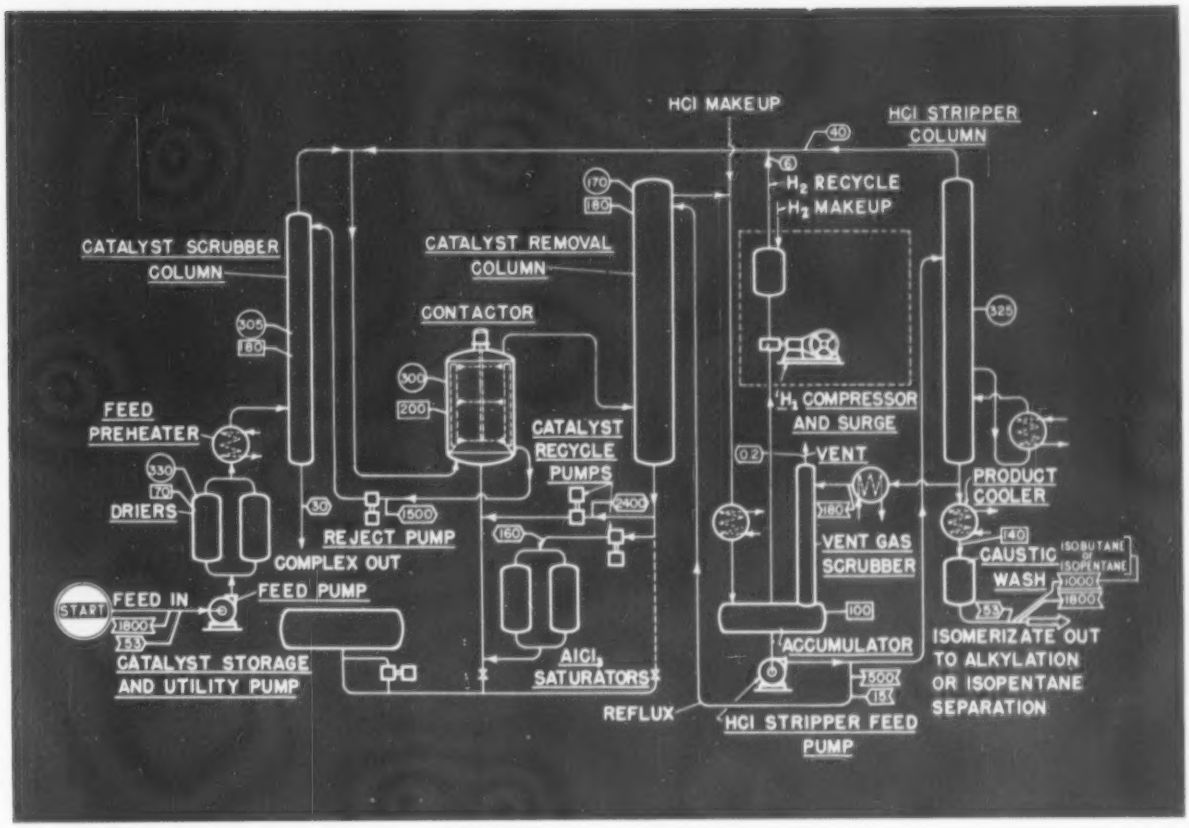
Yields—Isomate yields from hexane and mixed pentane-hexane feeds, processed both in once-through and in recycle operation, are shown in the accompanying table.

Commercial Installations—During World War II, the Isomate process was used in two commercial plants to make aviation-gasoline blending stocks. Based on this commercial operating experience, the process is now being improved and adapted to the production of high-octane, light blending stocks for motor gasoline production.

ISOMATE FEED AND PRODUCT INSPECTIONS

	FEEDS		PRODUCTS		
			Hexane		Mixed Pentane-Hexane
ASTM Distillation, F.:	Hexane	Mixed Pentane-Hexane	Once-Through	Recycle*	Once-Through
Initial Boiling Point	142	112	115	102	102
10 Percent	148	123	133	109	115
50 Percent	150	133	149	118	128
90 Percent	155	149	180	121	154
Maximum	171	164	300	128	245
Gravity, °API	75.7	80.8	77.4	85.9	82.0
RVP, psi	4.9	8.9	7.1	11.2	10.6
Motor Octane:					
Clear	63.5	68	79	92	81
+ 3 cc TEL	84.8	86	95	107	98
Research Octane:					
Clear	64	69	80	91	83
+ 3 cc TEL	86	89	95	106	97

* After removal of gas and naphthenic product; also this example is for a 1.5 recycle ratio



Liquid-Phase Isomerization—SHELL DEVELOPMENT COMPANY

Application—The process is applied to the isomerization of butane and pentane.

Description—The normal liquid paraffin (butane or pentane) is charged continuously at essentially atmospheric temperature through one of two feed dryers (used alternately and regenerated periodically), through a heater where the temperature is raised to about 180 F., thence through a packed catalyst-scrubber column and into the contactor. A liquid-liquid extraction of a small side-stream of the contactor catalyst with the feed takes place in the scrubber. The valuable active catalyst components pass back to the contactor in solution while the fluid inactive $AlCl_3$-hydrocarbon complex, which forms as a consequence of the small amount of side reactions, runs to the bottom of the column and is periodically drained off.

The contactor is a vertical autoclave equipped with a mixing device to provide intimate contacting of catalyst and hydrocarbon. A relatively short residence time, of the order of 10 to 15 minutes, in the contactor is sufficient to achieve a high conversion: 45 percent or better for butane and 55 to 60 percent for pentane. After phase separation from the catalyst in the baffled upper settling section of the contactor, the isomerizate flows to the catalyst-removal column for separation of dissolved catalyst by a simple fractionation. This recovered catalyst is pumped back to the contactor; the isomerizate is taken overhead, condensed, and pumped to the HCl stripper where the acid gas is removed and recycled to the contactor. The isomerizate, thus essentially freed of HCl, is given a caustic wash and sent to subsequent operations.

When isomerizing n-pentane, the reaction is effected in the presence of a small amount of hydrogen to suppress disproportionation reactions. The bulk of the hydrogen is recycled from the top of the catalyst column accumulator; however, some passes in solution to the HCl stripper and is recycled with the HCl.

The small amount of uncondensable gas that is formed is vented from the accumulator through a scrubber.

Operating Conditions—See Table 1.

Yields—See Tables 2 and 3.

Commercial Installations—Six installations.

TABLE 1—Design Conditions

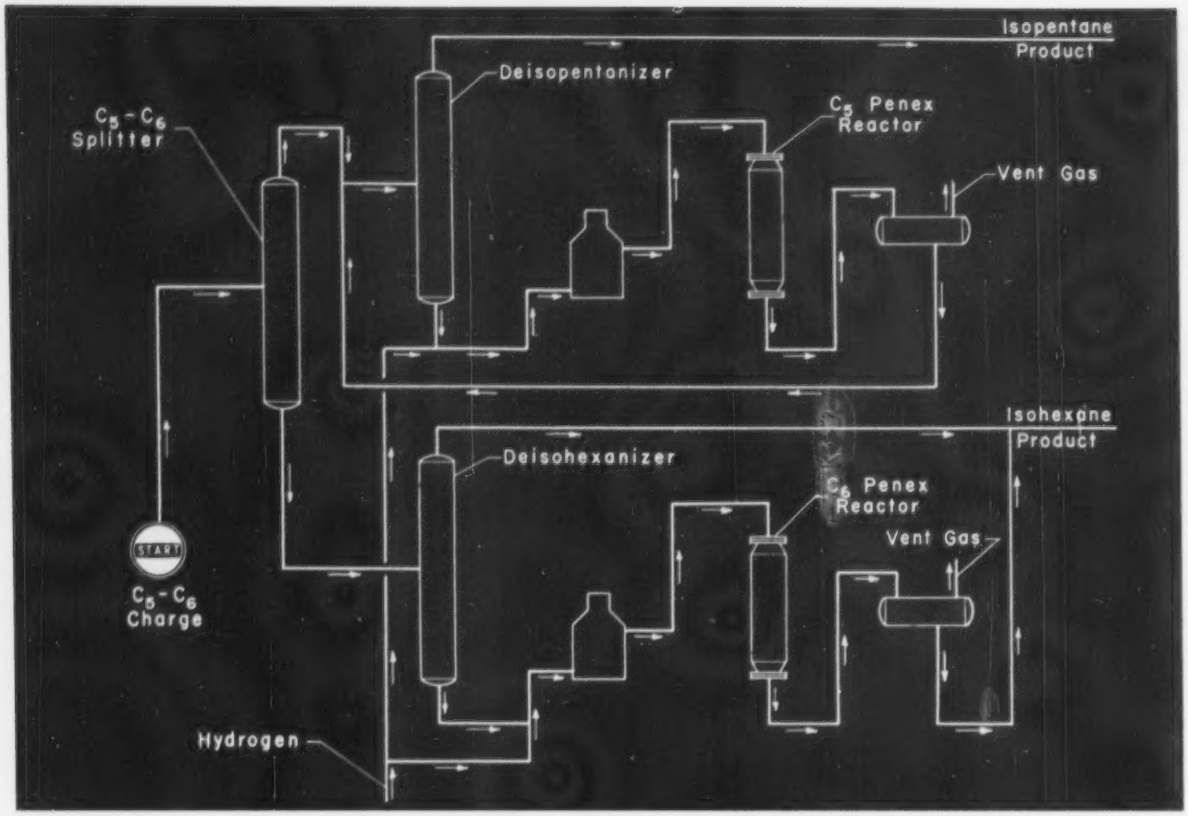
Process Conditions	Butane	Pentane
$AlCl_3$ content of catalyst, wt. %	9–10	3
Temperature in contactor, °F	176–194	176–212
HCl content of feed, weight percent	5	5
Average residence in contactor, min.	12 (2.5 LHSV)	12 (2.5 LHSV)
Catalyst to hydrocarbon vol. ratio in contactor	1	1
Operating pressure, contactor, psig	300	300
H_2 partial pressure in contactor		60 psi. minimum
H_2 concentration in feed, mole %		1.3

TABLE 2
Average Yield Data from Butane

Component, Volume Percent	Feed Stock	Single Pass Isomerizate
Lower boiling than butanes	0.0	<0.3
Isobutane	4.2	54.5
Normal butane	95.6	43.7
Isopentane	0.2	1.5
Hydrocarbons as $AlCl_3$ complex		<0.1
Yield of isoparaffin		97

TABLE 3
Average Yield Data from Pentane

Component, Volume Percent	Feed Stocks	Single Pass Isomerizate
Butanes	0.0	0.6
Isopentane	6.1	60.5
Normal pentane	90.7	35.0
Heavier than normal pentane	3.2	3.8
Hydrocarbons as $AlCl_3$ complex		<0.1
Yield of isoparaffin		97



Penex—UNIVERSAL OIL PRODUCTS COMPANY

Application—Penex is a newly announced process for improving the octane rating of pentane and hexane fractions from refinery naphthas and natural gasolines by isomerization over a platinum-containing catalyst in the presence of hydrogen.

Charge—The charge to pentane isomerization consists essentially of fresh n-pentane from the pentane splitter. The charge to hexane isomerization consists of n-hexane and higher boiling isomers.

Description—A flow diagram for the Penex processing of a C_5-C_6 mixture is shown. The charge is first split into an 82 to 120 F. C_5 fraction and a 120 to end-point C_6 cut. Close separation is achieved. Each of these cuts is again fractionated, the high-octane low boiling fraction containing isopentane, or hexane isomers, as the case may be, being removed as overhead product.

In the Penex processing of pentanes, the n-pentane fraction is mixed with hydrogen, heated, and charged to the reaction chamber. Since the overall heat of reaction is low, neither multiple bed reactors nor inter-bed heating is required. Hydrogen is not consumed or produced in the reaction in a significant quantity and, when required, may be furnished from a Platforming unit or other source of supply. The reaction is considered mild in severity.

The effluent is cooled, separated from the off-gas, and returned to the deisopentanizer for recovery of the isopentane produced. Unreacted n-pentane is recycled to the reactor in the deisopentanizer bottoms. The vent gas may be sent to gas recovery, burned as fuel gas, or recycled.

Isomerizing n-hexane using the Penex Process is basically similar to the operation previously described for pentanes. It is highly flexible in that several alternative operations are available to best suit the needs of the individual refinery. These include, but are not limited to, the following:

For instance, Penex processing of hexanes may be operated once-through as shown in the flowsheet, the reactor effluent being directly added to the deisohexanizer overhead to make a mixed product. Alternatively, the reactor effluent may be recycled to the deisohexanizer in order to return the unreacted, low-octane hexanes to the reactor. Still another variation is to return only a part of the reactor effluent to the hexane splitter, adding the rest directly to the splitter overhead.

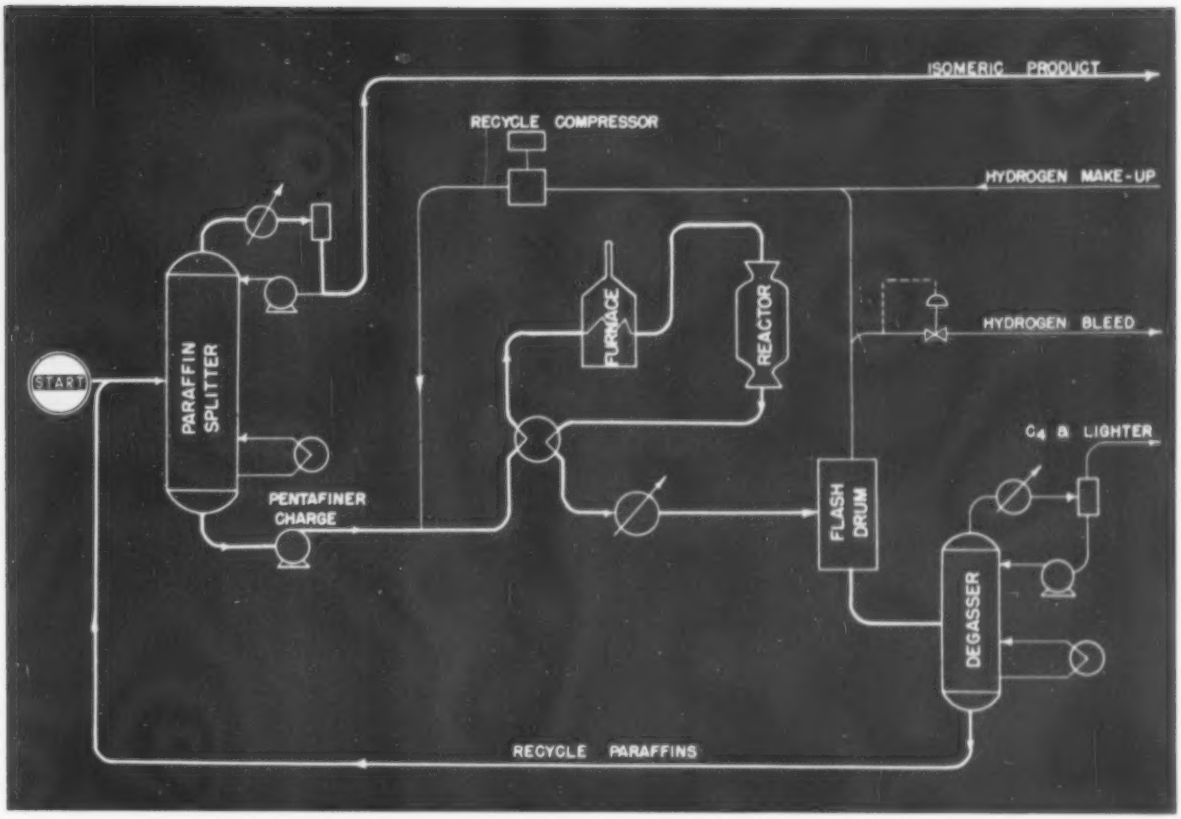
No provisions for regeneration of the catalyst are required. This feature not only reduces the original investment but greatly simplifies the operation and subsequent maintenance. Corrosion-resistant construction is not required. Neither catalyst nor reaction products are corrosive. Moreover, the non-regenerative nature of the process eliminates cyclical swings in temperature and composition of the atmospheres in contact with the reaction section characteristic of processes requiring regeneration.

Yields—High yields are characteristic of the Penex Process in either pentane or hexane isomerization. Typical yields from pilot plant data are shown below.

	Pentane Isomerization		Once-Through Hexane Isomerization		
	Feed, Mixed C_5's	Isopentane Product	Feed, Mixed C_6's	Reactor Effluent	Isohexane Product
Yields, Volume-Percent of Feed	100.0	99.0*	100.0	54.5	97.0†
Octane Rating:					
F-1 Clear	76.4	90.4	62.0	71.0	74.4
+ 3 ml. TEL	96.8	104.2	85.0	92.0	93.8
Reid Vapor Pressure, psi	18.2	21.1	6.1	7.5	7.5

* Isopentane content, 95 volume-percent.
† Mixture of hexane splitter overhead with reactor effluent.

Reference—PETROLEUM REFINER, vol 35, no 7, p 148 (July, 1956).



Pentafining—THE ATLANTIC REFINING COMPANY

Application—Atlantic Pentafining increases the octane rating of low-boiling normal paraffins by selective isomerization. The catalyst promotes chemical equilibrium with insignificant losses to butane and lighter.

Charge—Feed stocks should be rich in normal pentane, hexane, or heptane. All three may be isomerized together, but highest once-through conversions are obtained with a separate reaction section for each.

Product—The reaction product requires only de-gassing before inclusion in finished gasoline. No rerunning, sweetening, or other treatment is required.

Description—The flow diagram illustrates operation on a mixture of pentane, hexane, or heptane paraffins. The normal paraffin is first separated from its isomers in a conventional fractionating tower. The bottoms product, rich in normal paraffin, is charged to the Pentafiner.

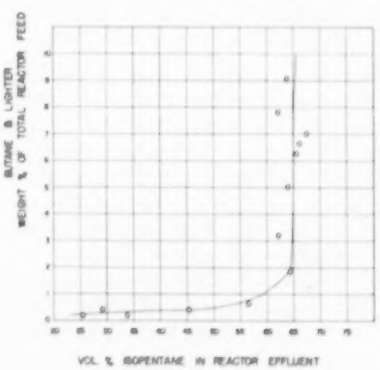
The normal paraffin is mixed with hydrogen recycle, preheated in exchange, and heated to reaction temperature in a furnace. The mixture is then passed downward through a single fixed bed of catalyst, wherein the temperature rises slightly. The reactor effluent is then cooled by exchange with the feed and condensed in a water cooler. The liquid separates from the recycle gas in a flash drum and then passes under level control to a simple degasser tower for removal of butanes and lighter. The gas from the flash drum is recycled.

After degassing, the equilibrium mixture is recycled to the splitter for separation of isoparaffins. A small amount of hydrogen must be continuously added to hydrogenate the products of cracking and sustain pressure.

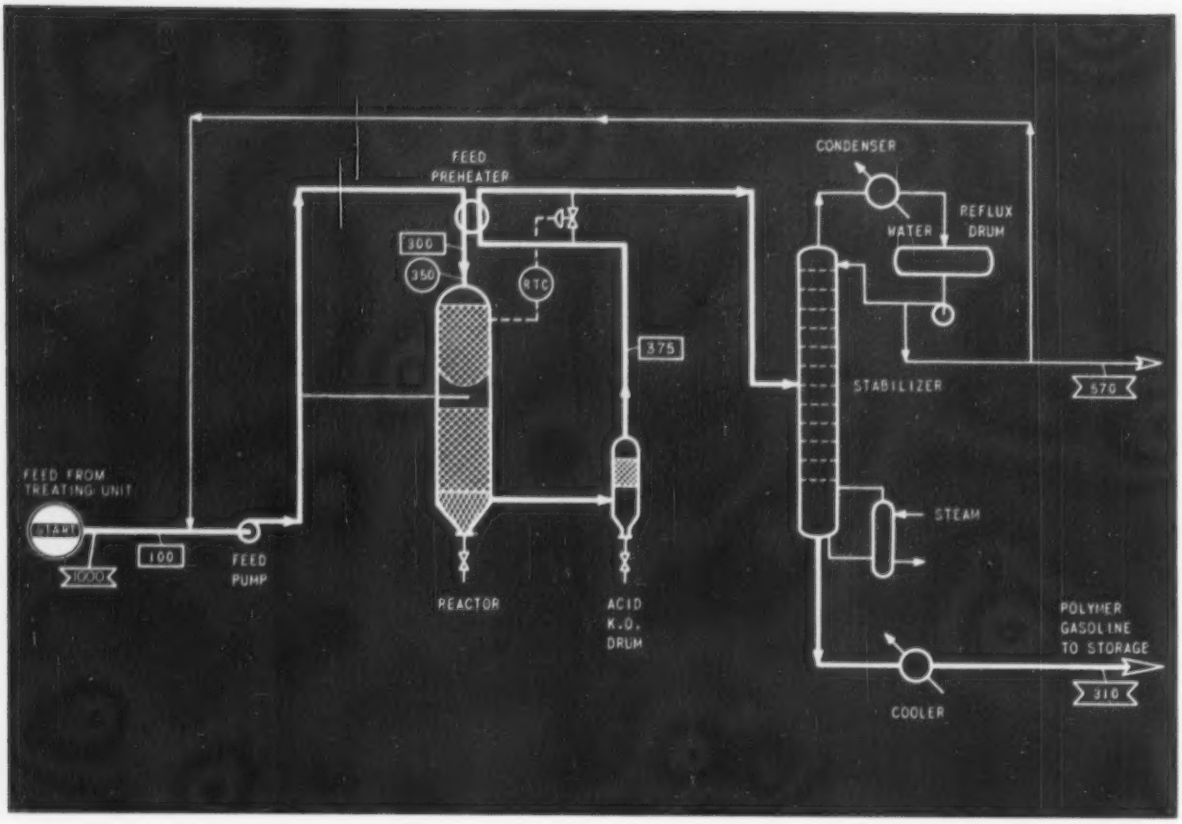
The catalyst is regenerated after long periods of operation with a dilute mixture of air and steam. Sulfur in the feed is handled by caustic washing to remove low-boiling mercaptans and hydrogen sulfide or by a conventional amine scrubber on the recycle gas.

Operating Conditions—Reactor temperature is 800-900 F., and operating pressure is in the range of 300 to 700 psig.

Yields—Typical once-through yields are illustrated by the plot of butane and lighter vs. percent isopentane in the reactor effluent. Ultimate yields of 95 percent isopentane are 98-99 volume percent of the fresh charge to the splitter.



Reference—PETROLEUM REFINER, vol 35, no 4, p 138 (Apr, 1956).



California Polymerization—CALIFORNIA RESEARCH CORPORATION

Application—The process is used: (1) to produce high octane polymer gasoline from olefins, or (2) to produce cumene from benzene and propylene.

Charge—The motor polymer process is equally applicable to total gas feed such as is obtained from cracking or reforming plants, or to a liquid stream containing propene or butenes, or mixtures of both. The cumene process uses benzene and a gas or liquid stream containing propane and propene. In all cases, the feed is caustic washed for the removal of H_2S and mercaptans and water washed for removal of nitrogen compounds.

Product—The F-1 clear octane rating of the polymers is in the range of 93 to 99, the F-2 clear in the range of 80 to 85, and blending values in the order of 115 to 120.

Description—In the reaction section, part of the fresh feed, either liquid or vapor, is preheated to about 300 F. by exchange with reaction mix coming from the reactor and is introduced into the top of the reactor. Polymerization of olefins is highly exothermic; and the temperature is limited to a maximum of 375 F. by the introduction of the balance of the cold feed through quench points appropriately located in the reactor. Reaction mix from the bottom of the reactor flows through a small vessel packed with limestone for removal of traces of acid exchanges with the top reactor feed, then flows to the product recovery section.

To prepare the catalyst, fine mesh quarts is supported on larger size quarts in the reactor. The reactor is filled with phosphoric acid and the excess drained off. A thin film of phosphoric acid remains on the quarts surface. To regenerate, the reactor is washed with water, steamed, and dried. After filling with phosphoric acid and draining off the excess acid, the reactor is then ready to go back on stream. This procedure can be completed in about 30 hours. In liquid feed operation, a catalyst life of at least 100 gallons of polymer per pound of phosphoric acid is obtained.

Operating Conditions—The motor polymer process is carried out between 300 and 375 F. and at pressures from 150 to 600 pounds. When the feed contains very high concentrations of olefins, a diluent (usually stabilizer overhead liquid) is added to provide sufficient heat capacity to absorb the heat of reaction.

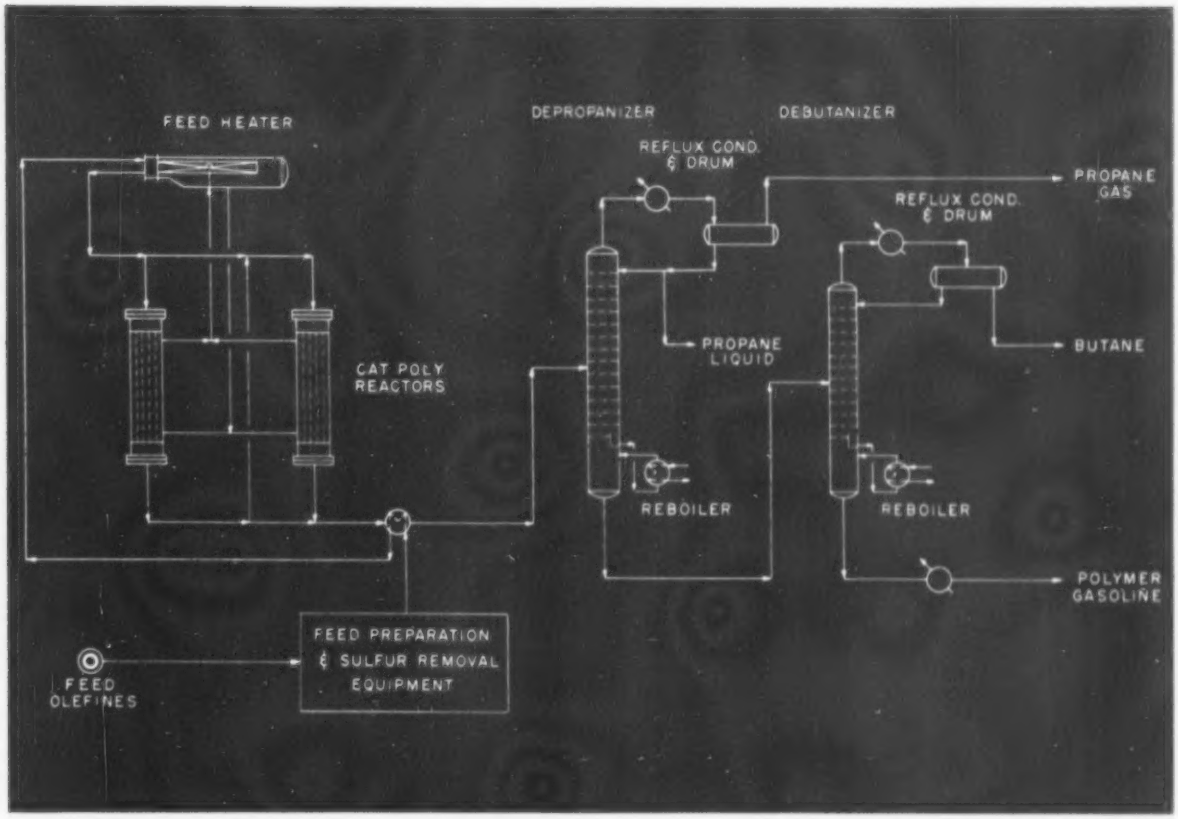
Yields—Conversions of 90 to 95 percent of the olefins are obtained. The table shows typical product properties:

	Propene[1] Polymer	Butene[2] Polymer
Gravity, °API	56.9	59.7
Reid Vapor Pressure, psi	0.5	2.0
Octane Number:		
F-1 Clear	93	99.0
F-1 + 3 ml TEL	99	Iso + 0.18
F-2 Clear	80.5	81.0
F-2 + 3 ml TEL	85.0	84.2
ASTM Distillation, F:		
IBP	222	140
10 Percent	267	211
50 Percent	311	242
90 Percent	381	361
End Point	408	443

[1] Debutanized and rerun (95 percent rerun yield).
[2] Debutanized.

Commercial Installations—The first unit was built in 1937. There are now 37 units in operation throughout the world. The process is also licensed by Hydrocarbon Research, Incorporated.

Reference—Petroleum Refiner, vol 31, no 8, p 79 (Aug, 1952).



Polyco Catalytic Polymerization—THE M. W. KELLOGG COMPANY

Application—The process is applied for chemically uniting propylenes and butylenes over a catalyst to produce a high-octane gasoline component.

Charge—The olefin-containing liquid stream of C_3 and C_4 hydrocarbons from a gas-recovery system provides a typical feedstock for this process.

Description—The feed is first treated to remove hydrogen sulfide and then washed with caustic to remove mercaptan sulfur. It is then heated to 300-400 F. and introduced into the reactor, which is kept at about 900 psig to maintain the material in the dense phase. Processing conditions may be altered depending on type of operation desired.

As the hydrocarbons pass through the reactor the olefins combine to form the polymers. The reaction is exothermic and the heat of reaction must be removed to provide control of catalyst temperature and to prevent the formation of heavy polymers. The reactor is essentially a heat exchanger with the catalyst in the tubes and a coolant in the shell. The coolant is usually boiling water, but can be circulating gas oil. Automatic control of reaction temperature is obtained by regulation of steam pressure or rate oil circulation. Chamber type reactors are also used, the catalyst being supported on screens in a vertical chamber. In this type of reactor heat of reaction is removed by recycling a stream of liquid hydrocarbons from the depropanizer or stabilizer.

Reactor effluent is heat exchanged with incoming feed and proceeds to a stabilizer, or a fractionation system as illustrated, which produces high-octane polymer gasoline, and also streams of high purity propane and butane suitable for LPG sales.

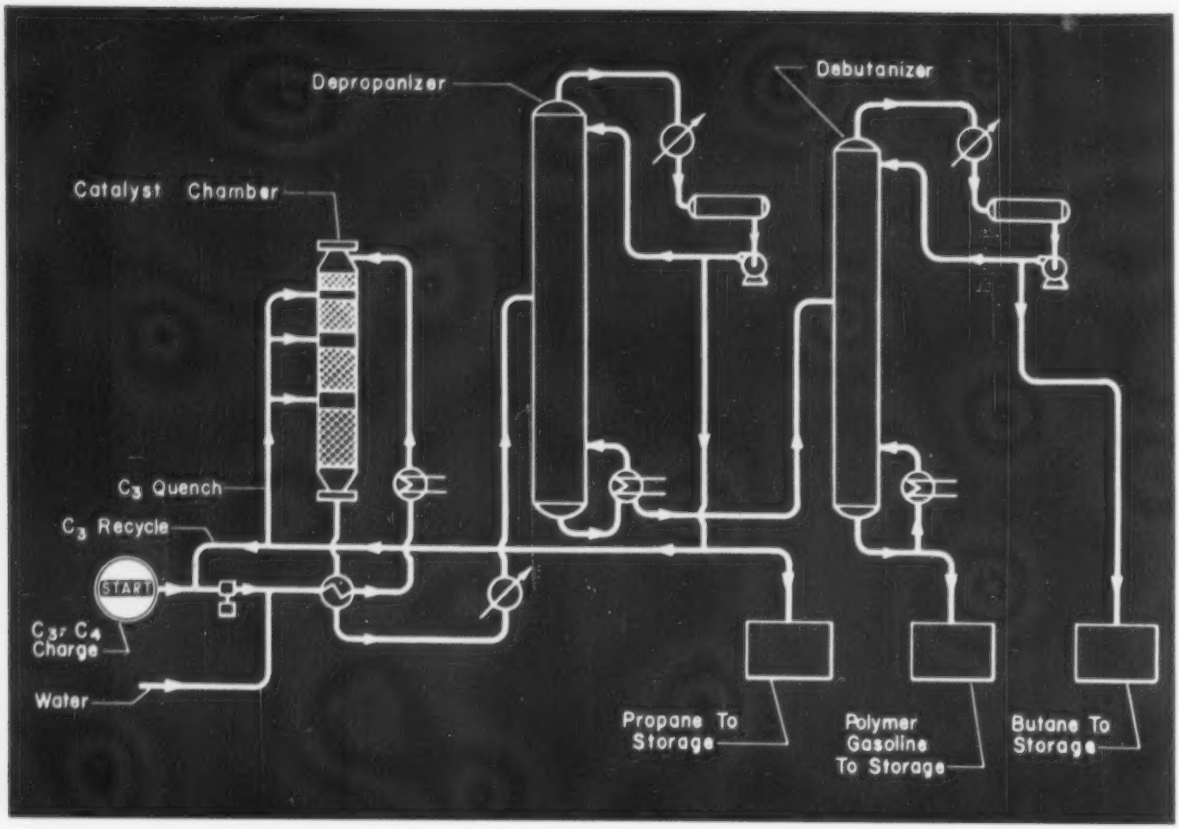
Operating Conditions—There are three principal types of operation, depending on the feedstock:

- Codimer Operation, which applies to hydrocarbon feedstocks consisting essentially of C_4's. The operation usually is carried out at temperatures in the order of 300 F. The product, called codimer, is unsaturated, but when hydrogenated has a clear ASTM octane number on the order of 95 and is, therefore, a very acceptable component for aviation gasoline.
- Mixed C_3-C_4 Operation, which charges mixtures of propylene and butylenes. This feedstock is usually polymerized at approximately 375-400 F. The polymer is unsaturated and has a clear octane of about 83 CFR-M and 96-98 CFR-R. Its blending value, however, is considerably over 100 by either rating method so long as the percentage in the blend does not exceed 10 or 15 percent.
- Propylene Operation, which applies to polymerization of propylene for motor fuels or production of tetramer. The operation is carried out at temperatures of approximately 350-425 F. and a pressure of about 700 psig. Conversions run approximately 80 percent with product octanes of 80 ASTM motor and 92 CFRR (clear). Tetramers production from propylene is accomplished by recycling light polymer.

The polyco catalyst is based upon copper pyrophosphate. It has a normal life of 100-200 gallons of polymer per pound of catalyst.

Yields—The table below furnishes typical results for various types of operation:

	Codimer Operation	Mixed C_3-C_4 Operation	Propylene Operation
Conversion, Percent of Olefin	80	90	70
Octane No.—ASTM Clear	95	83	82
Octane No.—CFRR Clear		96-98	92
RVP of Polymer, psi	2.0	2.0	2.5
IBP of Polymer, F	148	170	128
EP of Polymer, F	421	431	420
Gravity of Polymer, °API	60.4	60.1	59.8



Solid Phosphoric Acid Condensation—UNIVERSAL OIL PRODUCTS COMPANY

Application—The Condensation Process is used for converting propylene and butylenes to high octane gasoline blending agents; to polymerize pure propylene, or butylenes, into valuable chemical polymers; and to alkylate C_3-C_4 olefins with aromatic hydrocarbons in petrochemical syntheses.

Products—Selective polymerization of butylenes yield a "codimer" product which after hydrogenating, tests up to 95 Research octane number, clear, and to an F-4 performance number of 165, leaded.

The properties of products from other operations of this process are shown in the following table. They include the polymerization of propylenes to produce a full-boiling motor polymer and to produce tetramer, the polymerization of a refinery mixture of propylene and butane-butylenes, and the alkylation of propylene with benzene to yield cumene. The process is not limited to these compounds, however.

Description—The process consists of bringing the olefin-containing feed stream in contact with the catalyst, when polymerization reactions are desired, at temperatures ranging from 350 to 435 F. and pressures from 400 to 1200 psig. Alkylation conditions range in temperatures from 400 to 550 F. and pressures from 400 to 900 psi.

The catalyst is UOP Solid Phosphoric Acid. This highly active material is a pelletized and calcined mixture of phosphoric acid with kieselguhr. The reaction is exothermic but adiabatic conditions must be maintained for optimum yields of desired products and good catalyst life.

Two types of reactors are in use: (1) the tubular type in which the catalyst is packed into tubes surrounded by water jackets for temperature control, and (2) the more commonly used chamber type wherein the catalyst is divided into beds, between which a quench of cold reactor effluent is used to help maintain temperature, while a recycle of essentially paraffinic hydrocarbons is injected into the feed as a diluent for the same purpose.

The flowsheet shows the arrangement of equipment for the polymerization of propylene or butylenes and their mixtures to produce motor polymers. When charging propane-propylene to make a motor polymer the debutanizer is not required. The synthesis of tetramer (C_{12} olefins with a minor amount of C_{15} olefins) requires slight operating modifications and an additional fractionator as a re-run column.

The alkylation of olefins with aromatics requires the same equipment as in the production of tetramer with slight modifications to flow.

Yields—Motor polymer made from C_3-C_4 olefins is recovered in yields normally corresponding to 90-97 wt.-% on charge. Propylene motor polymer yields vary from 1 to 25 liquid volume percent of total polymer in the production of tetramer from propylene. The cumene yield is approximately 96 vol.-% of the propylene-benzene feed.

Properties of these products are shown in the accompanying table.

PROPERTIES OF PRODUCTS

	C_3 Motor Polymer	C_3-C_4 Polymer	Tetramer	Cumene
R.v.p., lbs.	4.4	9.2	0.0	0.0
Gravity, °API	59.5	66.1	51.0	32.1
A.S.T.M. Engler Dist.:				**A.S.T.M. Aromatic Dist.**
Initial Boiling Point, F	136	96	353	301
5 percent		130		302
10 percent	228	149	361	302
30 percent	258	201		302.5
50 percent	**276**	**228**	**371**	**303**
70 percent	292	263		303
90 percent	338	348	397	303
End Point	420	422	450	304*
Research octane with 3 ml. TEL	99.5	100	....	....

* Dry point.

Reference—Egloff, G., and Jones, E. K., "New and Advanced Developments in Tetramer, Cumene and Motor Polymer Manufacture," Proceedings Fourth World Petroleum Congress, 1955, Carlo Colombo, Publisher, Rome, Vol. 4, pp. 1-7.

Solvent Refining

PETROLEUM REFINER Process Handbook

SOLVENT REFINING methods are used primarily to extract (and dewax) lube oil fractions and to prepare feed stocks for catalytic cracking. By this method, hydrocarbon mixtures are separated on the basis of their relative solubilities. Aromatic compounds, naphthenic compounds and paraffinic compounds can be segregated without regard to volatility or the possibility of thermal decomposition (which often makes distillation of heavy oils difficult). The processes are physical in nature, the chemical character of the various hydrocarbons remaining unchanged.

Lube Oils—In lubricant manufacturing the good properties of paraffinic materials are sought. By the modern solvent refining processes, oils of any desired quality can be produced uniformly from a wide variety of crude oils, with the percentage yield being the principal variable.

The development of solvent processes has to a large extent eliminated the sharp distinctions once made between different crude oils on the basis of their suitability for lubricating oil manufacture. Now crude oils are evaluated more nearly on the amount of lubricating oil of specified quality which they will yield. The solvent method represents quite an advance over sulfuric acid treatment which was expensive and gave poor yields.

For extracting aromatics (low viscosity index constituents) from lube oil fractions, a single, mixed or double solvents can be used. Whatever the solvent, the extraction step generally is performed countercurrently in a packed tower. This step requires only a small part of the equipment as the difficult steps are in purification of lube oil and recovery of the solvent. Thus, the steps would be: Extraction with solvent, separation of bulk of solvent from oil, purification of oil, and purification of solvent.

Processes differ primarily in the solvent used: Furfural, Duo-Sol, phenol, nitrobenzene, Chlorex, and liquid sulfur dioxide. Duo-Sol, a double solvent, is a mixture of two immiscible solvents so that one solvent preferentially dissolves paraffins and the other, naphthenics and aromatics.

New trend in extraction is the use of a rotating disc contactor for the extraction step.

Dewaxing—The waxes in lube oil stocks are separated to produce finished lubricants with low pour points and also to recover wax either as a salable product or as stock for further processing. The waxes occur through the entire boiling range of lube oil stocks so that separation by distillation is not possible. Solvent dewaxing is favored over the older methods of "cold settling"; chilling, crystallization and filtration; or refrigeration and centrifugal separation. The solvent is used in such amounts as to insure a wax crystal structure and liquid viscosity most suitable for filtration.

Processes differ mainly in the solvents used: Methyl-ethyl-ketone and benzol, methyl-butyl-ketone, benzene-sulfur dioxide, chlorinated solvents, or propane. In the case of propane, no external refrigeration is necessary as evaporation of the propane chills the oil to the wax crystallization point. Newest trend in dewaxing is the use of urea in extractive crystallization as developed by Standard Oil (Indiana). With this process, no refrigeration is required. (PETROLEUM REFINER, August, p 182).

Deasphalting—Low carbon residue is desirable in feed stocks charged to catalytic cracking units. Here solvent refining competes with other feed preparation processes, such as vacuum distillation, visbreaking, coking, etc. Advantage of solvent refining is that it avoids high temperatures that lead to thermal decomposition of the feed stock. Here again processes differ by the solvent used: Propane, furfural, and alcohols.

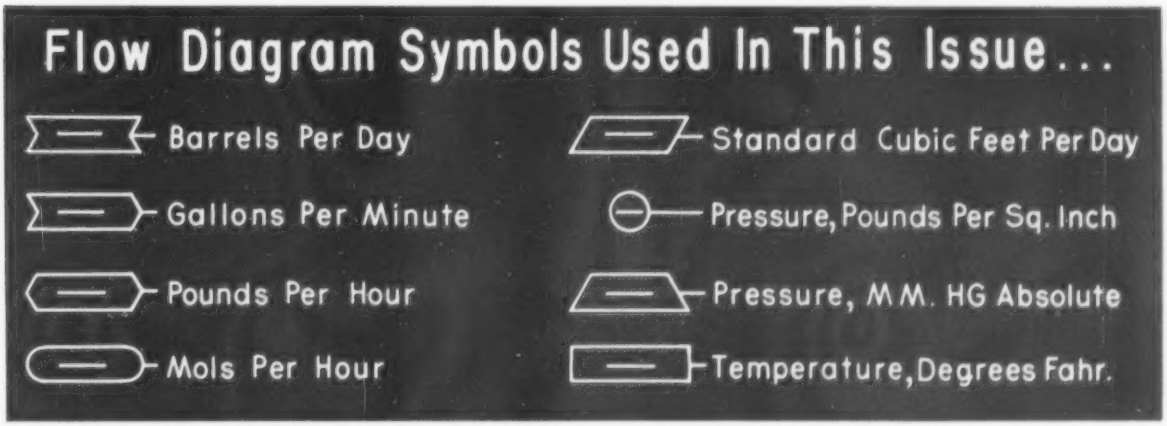
Solvent refining also has been applied (usually sulfur dioxide) to the extraction of aromatics and sulfur from gasoline, kerosine and diesel oil.

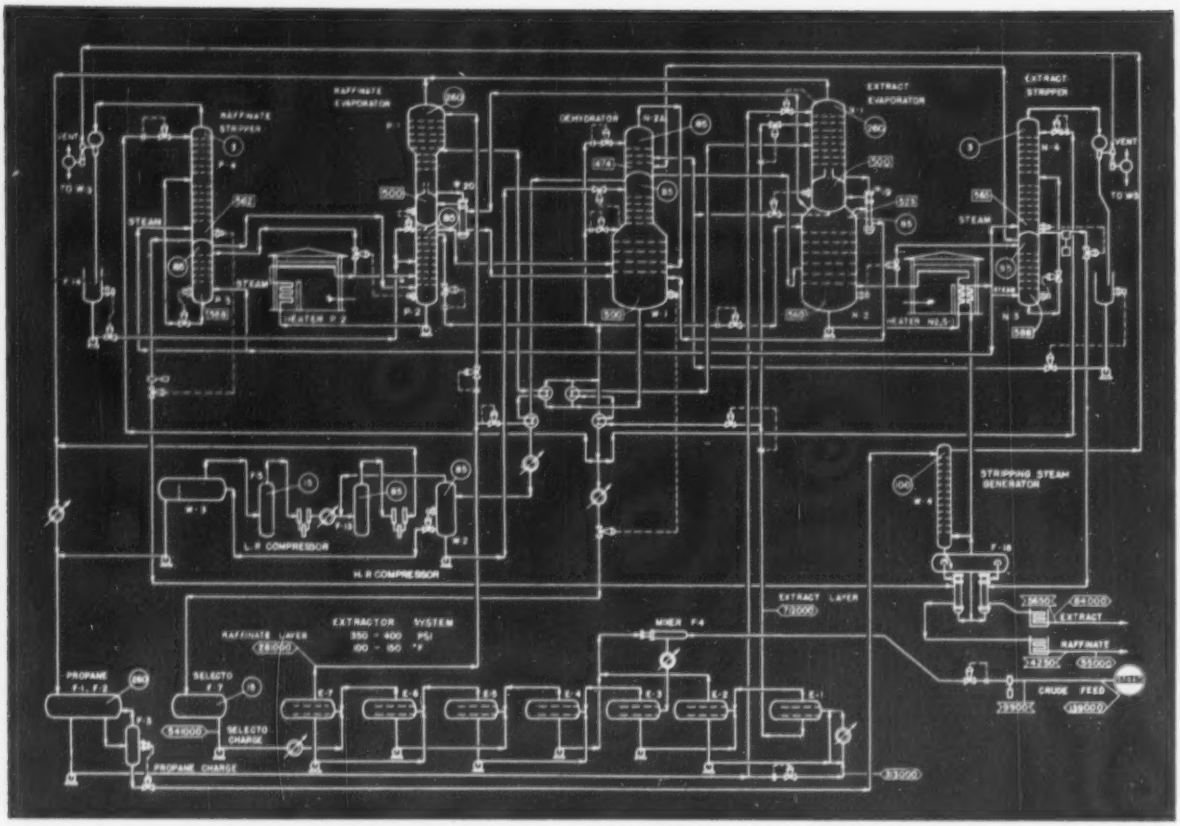
Biggest recent use of solvent refining is in catalytic reforming, where it is desired to extract aromatics so that the straight-chain paraffins from the reformate may be recycled. This is exemplified in the Rexforming process (p 223) and Iso-Plus Houdriforming Process (p 221).

REFERENCES

Kalichevsky and Kobe, *Petroleum Refining with Chemicals*, Elsevier Publishing Company, New York, 1956, pages 319-456.

"Solvent Refining," PETROLEUM REFINER, September, 1949, pages 244-263.


Flow Diagram Symbols Used In This Issue...
Barrels Per Day
Standard Cubic Feet Per Day
Gallons Per Minute
Pressure, Pounds Per Sq. Inch
Pounds Per Hour
Pressure, MM. HG Absolute
Mols Per Hour
Temperature, Degrees Fahr.



Duo-Sol—MILWHITE COMPANY, INC.

Application—The process is applied for the extraction of high viscosity index, light color, low carbon residue lubricants from any residual or distillate base stock.

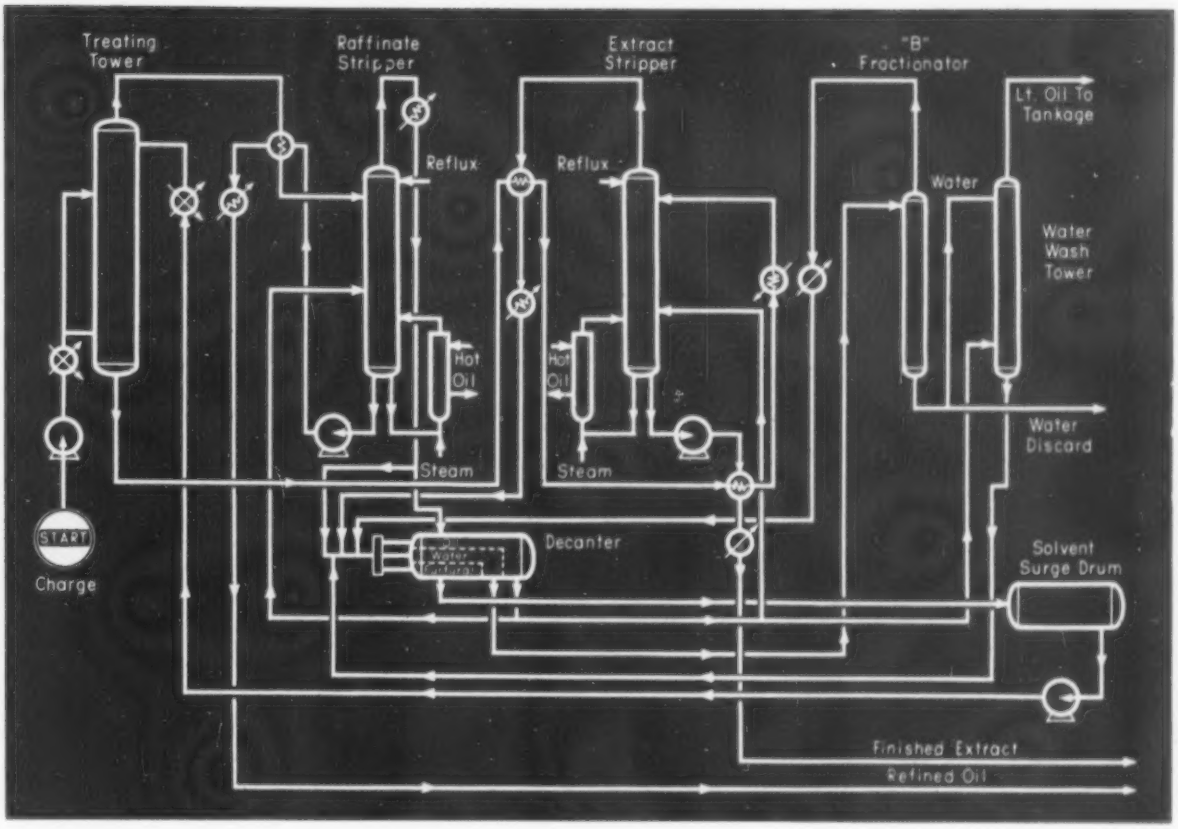
Description—The Duo-Sol process of solvent extraction is exclusive in its application of two solvents acting simultaneously and countercurrently on a charge stock introduced in the center of the extraction system. For maximum extraction efficiency, the countercurrent extraction is carried on in seven separate stages, identified as E-1 to E-7 on the flow diagram. The solvents employed, both of which are frequently refinery by-products, are propane which has affinity for raffinate and Selecto (a blend of cresol and phenol) which preferentially dissolves asphalts and undesirable aromatics, naphthenes and color bodies. In operation, the propane is charged into the E-1 end of the extraction system and Selecto into the E-7 end. In each extractor, the propane-raffinate leaves the top of the extractor vessel and passes to the next higher numbered stage, while the Selecto-extract is withdrawn from the bottom of each stage and pumped to the next lower numbered stage. Charge stock is generally admitted into E-3, together with raffinate phase from E-2 and extract phase from E-4. Raffinate progressing from E-3 to E-7 is treated in each stage with less diluted, more effective Selecto and extract from E-3 is stripped of all desirable constituents by propane in stages E-2 and E-1.

The solvents propane and Selecto are removed from the extract and raffinate layers by distillation in raffinate and extract evaporators P-1—P-2 and N-1—N-2, which consist of a upper section for higher pressure propane evaporation, and a lower section of the same vessel for evaporation of Selecto at low pressure. The final traces of Selecto are removed by a steam stripping in towers P-3, P-4, N-3, and N-4. This steam is removed from the distillation system as a constant boiling mixture at the top of tower W-1. After condensation and decantation the water containing Selecto is pumped to the propane charge tank to reduce the Selecto content to approximately two percent; from here it flows to tower W-4. Steam overhead of W-4 containing Selecto is employed for vacuum jets, while the steam obtained from the steam drum (F-19), essentially Selecto-free, is employed after superheating for the final steam stripping in the vacuum towers P-4 and N-4.

Yields—Typical extraction results are tabulated below:

	East Texas-Louisiana Residuum	San Joaquin Long Residuum	East Texas Distillate	Van Zandt Long Residuum	Iraq Long Residuum
Charge Stock:					
Gr. (ASTM)	15.2	14.9	26.2	17.4	14.8
Vis. @ 210° F. (SUS)	760	257	47.4	179	194
V.G.C.	.876	.893	.839	.879	.899
Flash (°F.)	595	470	420	435	420
Raffinate—(Dewaxed):					
Gr. (ASTM)	26.5	29.3	29.9	27.5	27.6
Vis. at 210° F. (SUS)	143.3	61.0	48.0	64.4	54.2
V.G.C.	.809	.808	.811	.818	.822
V.I.	95	94	95	98	100
Pour	0	0	0	0	0
Color (ASTM)	8	4¼	2½	5	3½
Conradson Carbon	.4	.1	.02	.25	.25
Duo-Sol Yield:					
Percent by Volume	43.6	34.7	73.0	60.9	55.0
Extract:					
Specific Gravity	1.026	1.0177	1.000	1.053	1.073

Commercial Installations—Nineteen.



Furfural Extraction of Gas Oils—TEXACO DEVELOPMENT CORPORATION

Application—The process is employed for the solvent extraction of diesel fuel oils, burning oils and cracking stocks to remove materials having low cetane number as well as such undesirable materials as unstable, acidic, sulfur, organo-metallic and nitrogen compounds.

Product—The resultant treated oils have a higher cetane number and show a marked degree of improvement in engine cleanliness, improved burning qualities and greatly reduced sulfur, nitrogen and metals content.

Description—This process for the extraction of gas oils is an outgrowth of the Furfural Refining process which is widely used for refining lubricating oils.

The extraction temperatures and furfural treating ratios for gas oils are generally lower than when refining lubricating oil stocks. The principal difference between these two processes, however, lies in the equipment for the recovery of furfural from the raffinate and extract solutions.

Following an azeotropic distillation, solvent-free raffinate and extract streams are taken from the base of the respective strippers, while the overhead vapors from these columns comprising an azeotropic mixture of oil, water and furfural are condensed and conducted to a decanter. Three liquid phases form in this decanting type of accumulator and all three of the components are present in each phase. The heaviest phase is predominantly furfural which is returned to the solvent circulating system. The intermediate phase is predominantly water which is charged to the water removal equipment from which solvent-free water is withdrawn. The overhead vapors are returned to the system for further separation and recovery of the oil and furfural. The lightest or oil-rich phase is pumped to a tower in which the furfural is extracted from the oil with water. The percentage of light oil to be recovered in this way is dependent upon the initial boiling point of the gas oil charging stock, varying from a negligible percentage for a stock with an initial boiling point of 500 F. or higher to about 3 percent when processing a stock having an initial boiling point as low as 420 F.

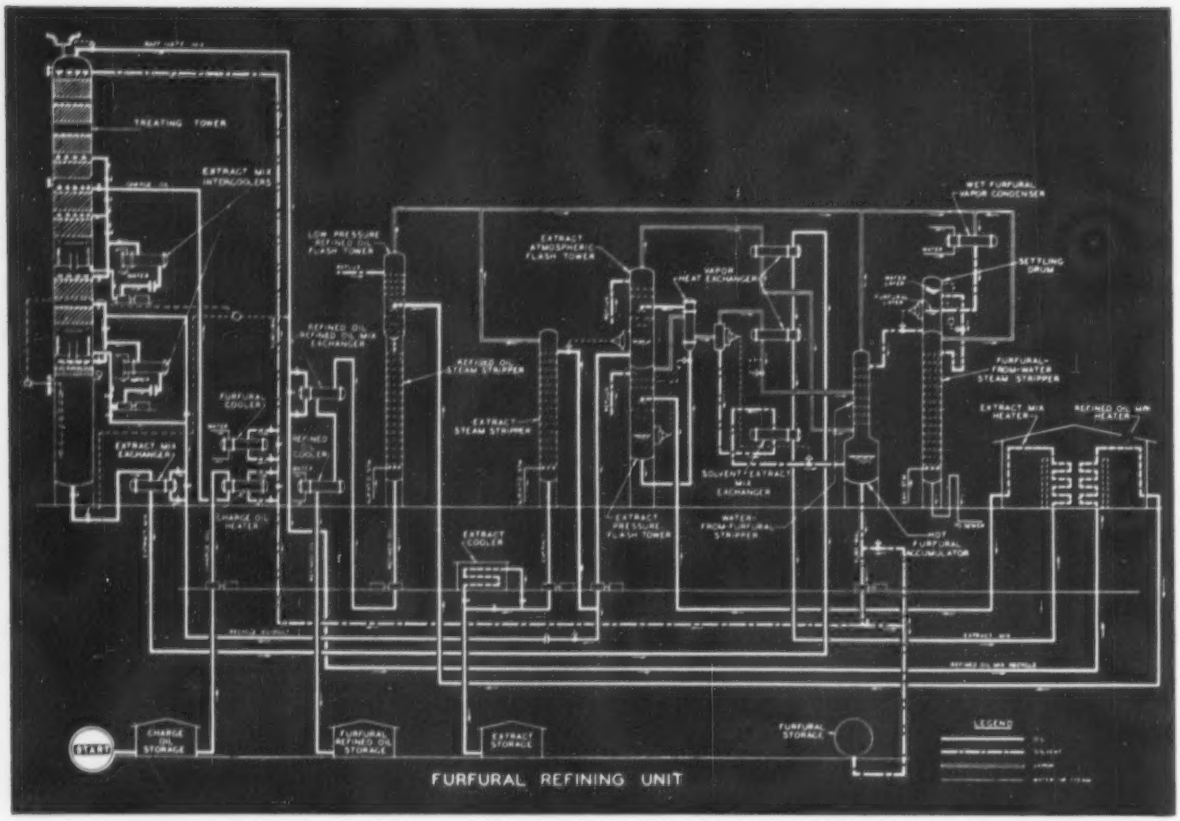
Compensation can readily be made to permit the use of furfural containing a small percentage of oil and water.

This process is characterized by low solvent requirements which range from 25 percent of the charge oil when extracting a cycle gas oil stock for re-charging to a catalytic cracking unit to about 40 percent for a catalytic gas oil stock extracted for the production of high quality diesel fuel or furnace oils and to about 80 percent when processing virgin gas oil stocks for the production of fuels, burning oils or cracking stocks.

Yields—The yield of product raffinate is dependent upon the nature of the charge stock and the degree of quality improvement desired. For example, when extracting a virgin gas oil derived from West Texas crude to a raffinate yield of 82 percent, the sulfur content was reduced from 1.12 to 0.49 percent, while the cetane number was increased from 53.2 to 62.9. Similarly, in the extraction of a catalytic cycle gas oil from Middle East crude oil, the sulfur content was reduced from 1.39 to 0.39 percent and the cetane number increased from 44.8 to 62.5 with a raffinate yield of 78.9 percent.

Commercial Installations—Six.

Reference—PETROLEUM REFINER, vol 29, no 9, p 196 (Sept. 1950).



Furfural Refining—TEXACO DEVELOPMENT CORPORATION

Application—The process is employed to extract undesirable components from petroleum lubricating oil stocks in order to produce oils of high quality.

Product—The raffinate or refined oil product has greatly improved temperature viscosity characteristics and contains all the desirable lubricating oil components present in the charge stock.

Description—In operation, the untreated oil is introduced into a continuous counter-current extractor at some midpoint and at a predetermined temperature. The temperature of the furfural which enters near the top of the extractor depends largely upon the miscibility relationship between the furfural and the oil being refined. A substantial temperature gradient is maintained between the top and bottom of the tower by indirect, external water coolers. Extraction generally is accomplished by passing the furfural in dispersed phase downward over raschig ring nests through the prevailing oil phase.

The extraction efficiency can be maintained at a high level by the controlled recirculation of the material extracted. The recirculated extract serves to enrich the furfural phase with the more soluble material and thus to displace from solution the last remaining traces of cycle oil which joins the rising oil phase being refined.

The furfural refining unit represented in the accompanying flow diagram comprises an extraction or treating section, sections for the recovery of furfural from the refined oil and extract solutions respectively, water removal facilities, process surge tanks and pumping equipment. Because of its stability over a wide range of operating conditions, furfural lends itself to a variety of methods of recovery.

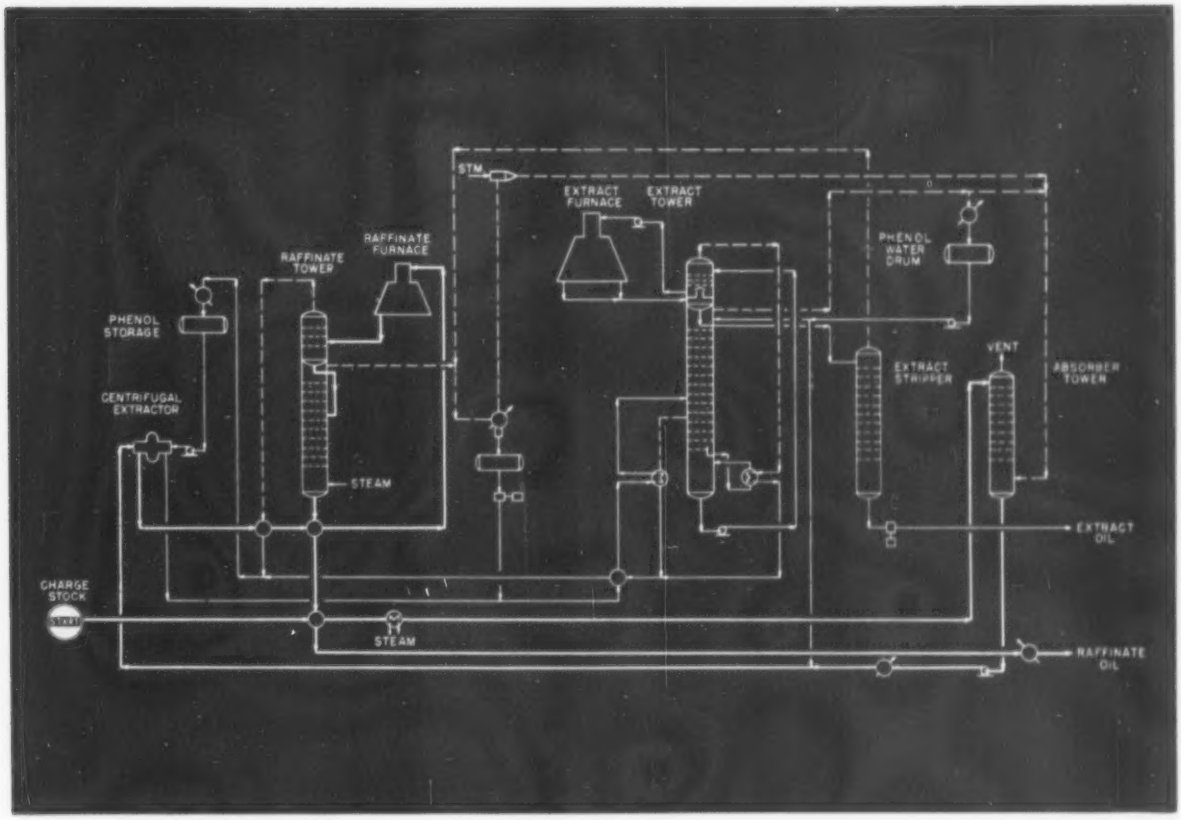
Furfural has a high solvent power for those components of petroleum which are relatively unstable to oxygen as well as other undesirable materials including color bodies, resins, carbon-forming constituents and sulfur compounds.

Yields—The operating conditions employed and the yields of raffinate obtained depend upon the nature of the charge stock and the degree of refining desired. Data of just a few of the many stocks typical of those processed for lubricating oil production are shown below:

Commercial Installations—Fifty units. In addition, 4 units are under construction or being designed.

Reference—*Industrial and Engineering Chemistry,* vol 40, no 2, p 220 (Feb, 1948).

Crude Source	East Texas	East Texas	Oklahoma City
Grade	Light Neutral Distillate	Deasphalted Bright Stock Residuum	Intermediate Viscosity Distillate
Physical Characteristics Charge Oil:			
Gravity, °API	28.3	23.1	25.4
Viscosity, SSU/210 F	41.0	132.6	69.3
Carbon Residue, percent	0.07	1.40	0.52
Raffinate:			
Gravity, °API	32.5	29.6	30.9
Viscosity, SSU/210 F	40.4	102.3	58.4
Carbon Residue, percent	0.01	0.20	0.03
Yield, percent by volume	85.0%	60.0%	76.9%
Dewaxed Raffinate:			
Gravity, °API	29.8	27.2	29.7
Viscosity, SSU/210 F	43.0	140.6	63.2
Viscosity Index	96.0	94.1	96.0
Pour Point, °F	20	0	0
Extract Gravity, °API:	8.0	13.9	9.5



Phenol Extraction—THE M. W. KELLOGG COMPANY

Application—The process utilizes liquid-liquid extraction for improving the viscosity index, color and oxidation resistance, and for reducing the carbon and sludge-forming tendencies of lubricating oils.

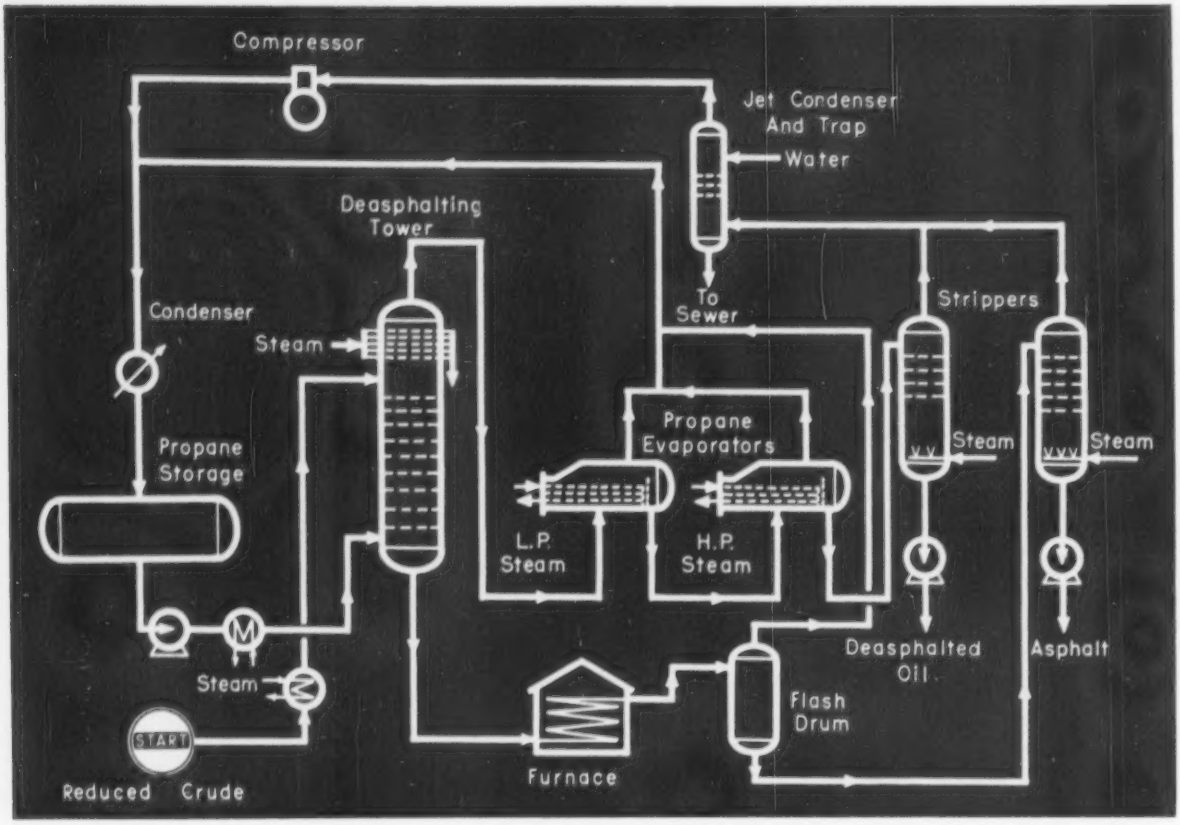
Description—In this process the feed stock flows first through a phenol absorber tower to recover the small amount of phenol from steam being discharged from the plant. The feed is pumped from the absorber to the centrifugal extractor. Raffinate phase leaves the centrifugal extractor and, after heating, is flashed into the evaporator section of the raffinate tower. Phenol vapor from this section flows to a condenser and storage tank. The raffinate oil flows down to a section in which it is steam-stripped free of solvent and withdrawn as bottoms to storage. Steam and solvent vapors flow from the stripping section to vacuum equipment.

The extract phase from the centrifugal extractor is pumped through heat exchange to enter a drying tower, in which all water is removed as a phenol-water azeotrope. This vapor is condensed and enters the phenolic-water drum. Dry extract solution is pumped from the bottom of the phenol tower to a top evaporator section in which a portion of the phenol is flashed. The remaining extract solution is pumped from the evaporator section through a furnace coil. Extract oil flows from the evaporator section to a steam stripper in which the last traces of solvent are removed and then to storage.

Yields—The accompanying table illustrates typical yields and product inspection for several stocks:

	Deasphalted East Texas Residue	West Edmond SAE 40 Stock	Deasphalted Van Zandt Residue
Solvent/Oil Ratio Volume	3.0	2.13	3.48
Treating Temperature—F	245	201	200
Raffinate Yield—Volume Percent	64.5	88.2	59.3
Inspections-Untreated Oil:			
Gravity—°API	23.0	28.3	21.2
SSU Viscosity @ 210 F	159.0	77.4	180.1
Color ASTM	5	3	7
Carbon Residue, Conradson, Weight Percent	1.6	0.16	2.58
Dewaxed (Zero Pour) Viscosity Index	59	81	
Raffinate Inspections:			
Gravity—°API	29.0	30.2	27.3
SSU Viscosity @ 210 F	110.7	72.3	136.6
Color ASTM	4½	2—	6
Carbon Residue, Conradson, Weight Percent	0.26	0.04	
Dewaxed (Zero Pour) Viscosity Index	94	93	101.4

Commercial Installations—There are a total of 22 foreign and domestic units in operation or under construction.



Propane Deasphalting—THE M. W. KELLOGG COMPANY

Application—Propane Deasphalting is a solvent extraction process used to segregate viscous petroleum fractions for finishing into cylinder stocks, bright stocks, and aviation lubes. On Pennsylvania cylinder stocks the same process, called Propane Deresining, is used to improve the color and carbon residue of the deresined oil to be finished as bright stock.

Charge—Vacuum reduced crude of appropriate length. When producing a lubricant of constant viscosity, shortening the charge stock has the effect of decreasing yield and improving color and carbon residue.

Product—Deasphalted oil which, if produced from a reduced crude of proper length, is normally of specification color and carbon residue after only solvent treating and dewaxing.

Description—The feed is brought to extraction temperature by exchange with exhaust steam or cooling water and charged to the deasphalting tower. Liquid propane, introduced near the bottom of the tower, is contacted countercurrently with the descending heavy oil. Steam coils near the top of the tower, by imposing a temperature gradient, provide reflux so as to maximize the selectivity of the separation.

The deasphalted oil solution withdrawn overhead, which contains most of the propane, is heated under pressure to evaporate the solvent, the heat being obtained largely from exhaust steam. The last traces of propane are removed by direct contact with steam at low pressure in the deasphalted oil stripper.

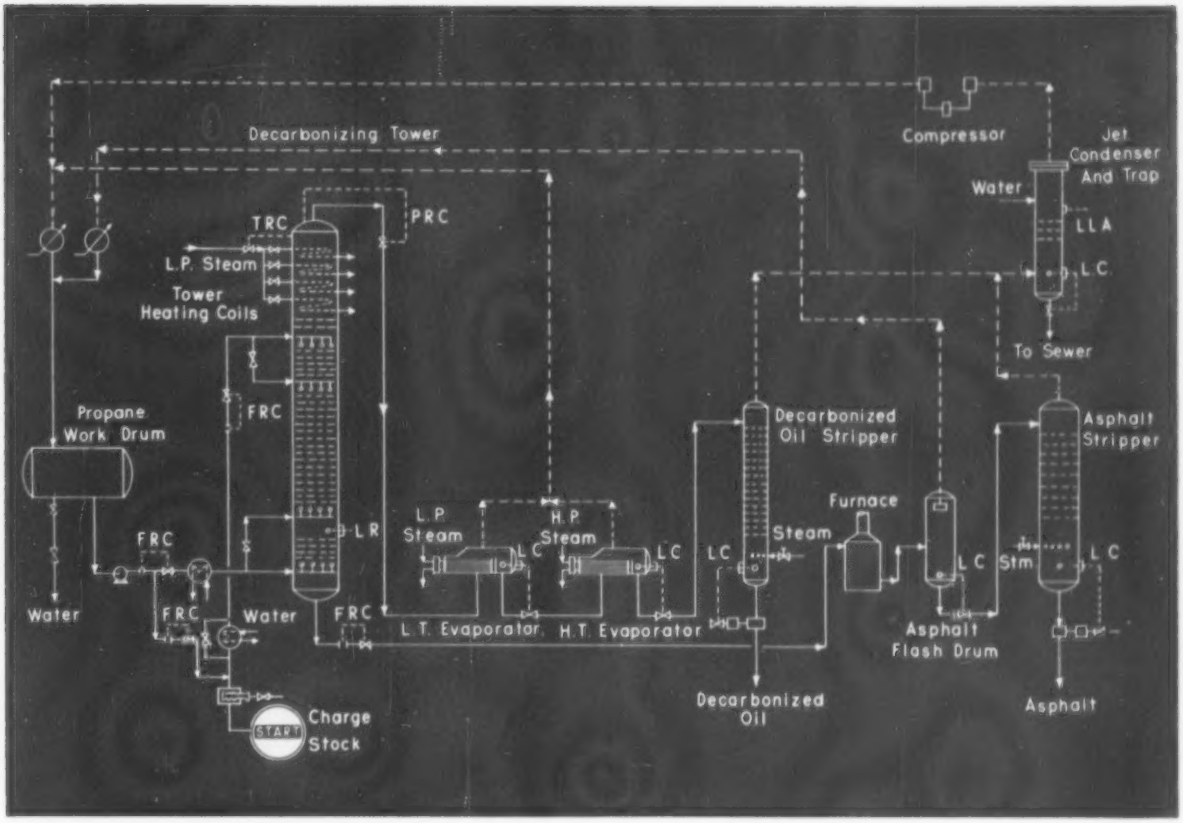
The asphalt solution from the bottom of the deasphalting tower is heated in a furnace, following which propane vapors are separated in a pressure flash drum. The final stripping is accomplished at low pressure as with deasphalted oil.

Operating conditions in the deasphalting tower depend upon the length of the charge stock, desired viscosity of deasphalted oil and the sharpness of separation required. Normally, the top temperature ranges between 140 and 170 F. and the pressure from 400 to 550 psi. Solvent/oil ratios of 5/1 to 13/1 are used and temperature gradients are usually between 10 and 35 F.

Yields—Typical yields are shown in the table:

	Oklahoma	Iraq	Le Duc	Illinois		Pennsylvania	West Edmond
Reduced Crude:							
Gravity—°API	19.3	7.1	12.1	13.7		25.1	19.3
SSU Vis. at 210 F.	385	4888	2050	1760		220	514
Conradson Carbon, Weight Percent	7.3	19.7	17.1	13.4		2.76	5.9
Deasphalted Oil:							
Yield—Vol. Percent	75.6	34.1	47.1	44.3	50.7	83.7	39.4
Gravity—°API	23.6	20.2	22.7	24.2	23.4	26.6	24.7
SSU Vis. at 210 F.	141	179	199	158	190	144	155
Color ASTM	6	8	6—	5—	5—	4½—	4½—
Conradson Carbon, Weight Percent	1.48	2.36	1.7	1.2	1.4	1.1	0.97
Asphalt:						**Resins**	
Yield—Vol. Percent	24.4	65.9	52.9	55.7	49.3	16.3	60.6
Specific Gravity °API	1.0227	1.0639	1.0542	1.023	1.030	0.9529	15.8
Softening Point °F	144	145	176	135	145	.....	.....
S.F. Viscosity C. 210 °F	.....	.....	.....	.....	.....	339	.....
Solvent/Oil Ratio—Volume	7.8	9.9	7.9	8	8	12.7	6

Commercial Installations—There are 29 units in the U. S. and Canada and 13 foreign units.



Propane Decarbonizing—THE M. W. KELLOGG COMPANY

Application—Propane Decarbonizing is a solvent extraction process used to recover an additional fraction of catalytic cracking stock from fuel residua.

Charge—Topped or vacuum reduced crude. Decarbonizing can also be used in conjunction with vis-breaking.

Product—Decarbonized and de-metallized oil and a high-grade, straight-run asphalt. Decarbonized oil is a premium catalytic cracking stock.

Description—As shown in the accompanying flow chart, the feed is reduced in temperature by heat exchange and cooling and charged to the decarbonizing tower. Liquid propane, introduced near the bottom of the tower, is contacted counter-currently with the descending heavy oil. Steam coils near the top of the tower, by imposing a temperature gradient, provide reflux so as to maximize the selectivity of the separation.

The decarbonized oil solution withdrawn overhead is heated under pressure to evaporate solvent, most of the heat being obtained from exhaust steam. The last traces are removed by direct contact with steam at low pressure in the decarbonized oil stripper.

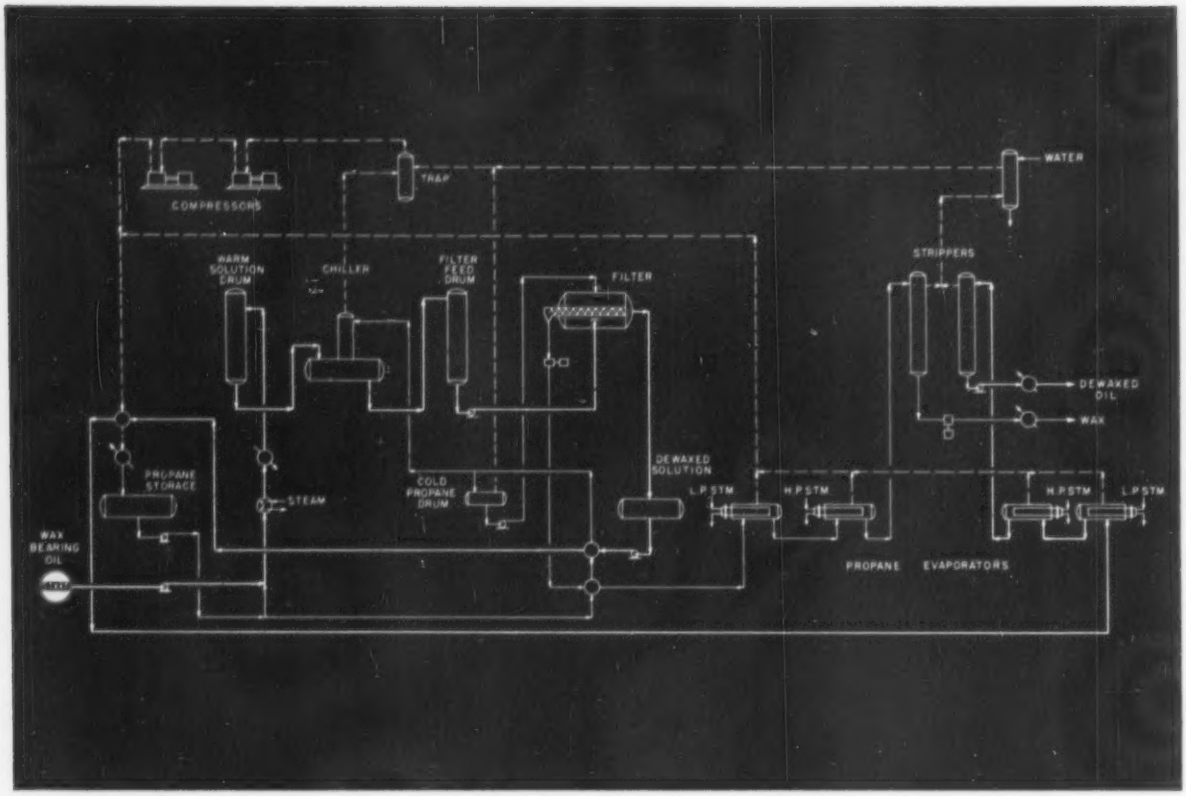
The asphalt solution from the bottom of the decarbonizing tower is heated in a furnace, following which solvent vapors are separated in a pressure flash drum. The final stripping is accomplished at low pressure as with decarbonized oil.

Operating conditions—Normally, the top temperature ranges between 160 and 190 F. and the pressure from 450 to 600 psi. The solvent ratio and temperature gradient are determined by the selectivity requirements.

Yields—Typical yields and product properties shown below are illustrative only.

	A	B	C	D	E	F	G
Reduced Crude:							
Volume Percent Crude	11.1	19.8	22.2	32.3	29.2	20.0	16.0
Gravity, °API	11.3	13.0	5.3	10.1	12.0	6.3	9.6
Conradson Carbon Weight Percent	15.0	13.3	21.5	16.0	12.1	22.2	18.9
SSU at 210 F	2,193	812			526		
SFs at 210 F			772	162		990	179
SiO_2-free ash, ppm	489	149	350	237	936	848	265
Metals, ppm:							
Vanadium	23.1	27.6	84.1	61.6	27.6	136.0	30.0
Nickel	14.2	11.9	27.6	19.9	16.0	139.0	46.6
Iron	18.2	56.6	13.2	6.7	13.2	93.0	39.3
Copper			3.7	0.8	1.6	0.94	1.4
Decarbonized Oil:							
Volume Percent Charge	62.9	69.0	35.0	47.0	66.0	52.8	67.8
Gravity, °API	19.0	20.5	19.3	20.3	19.6	18.3	17.8
Conradson Carbon, Weight Percent	4.2	2.6	4.3	2.6	2.2	5.3	5.4
SSU at 210 F	294	163	193		113	251	250
SiO_2-Free Ash, ppm	9.2	8.9	8.8	7.6	6.2	25.5	10.7
Metals, ppm:							
Vanadium	1.23	0.36	1.88	0.73	1.34	2.3	1.4
Nickel	1.10	0.56	0.92	0.38	0.99	8.1	3.9
Iron	0.49	0.90	0.96	1.70	0.66	3.5	Trace
Copper			0.03	0.04	0.15	0.03	0.02
Asphalt:							
Volume Percent Charge	37.1	31.0	65.0	53.0	34.0	47.2	32.2
Specific Gravity	1.076	1.086	1.087	1.059	1.083	1.119	1.120
R & B Soft. pt., °F	188	196	142	132	171	246	224
Percent of Metals in reduced Crude rejected to asphalt Fraction	97.1	98.8	99.1	98.6	96.6	98.2	97.1

Commercial installations—At present, five Propane Decarbonizing units with a total capacity of 66,000 barrels per day are in operation. Others are being engineered, planned, or operated part time.



Propane Dewaxing—THE M. W. KELLOGG COMPANY

Application—The process is applied to dewaxing lube oil stocks. These units have also been applied to the Propane De-Oiling Process, where propane is used to remove oil from crude waxes produced in the dewaxing process.

Charge—Charge oils ranging from paraffin distillates of 70 SUS at 100 F. to cylinder stock of 250 SUS at 210 F. viscosity have been handled.

Product—Zero or lower pour test oils with exceptionally low cloud points as well as waxes of low oil content.

Description—Oil and propane are continuously charged through a heater which insures that all wax crystals are dissolved. The charge solution, after being held briefly in the warm solution tank, enters one of two parallel chillers in which its temperature is reduced at a controlled rate to filtering temperature by evaporation of propane. During chilling, wax crystals form and remain suspended in the propane-oil solution. The chilled slurry is charged to one or more continuous rotary filters via a filter feed tank. The wax cake on the filter is washed with cold propane to free it of oil, after which it is discharged to the wax recovery system. The filtrate, which comprises the wax-free oil together with most of the solvent and wash propane, is processed in a similar recovery system.

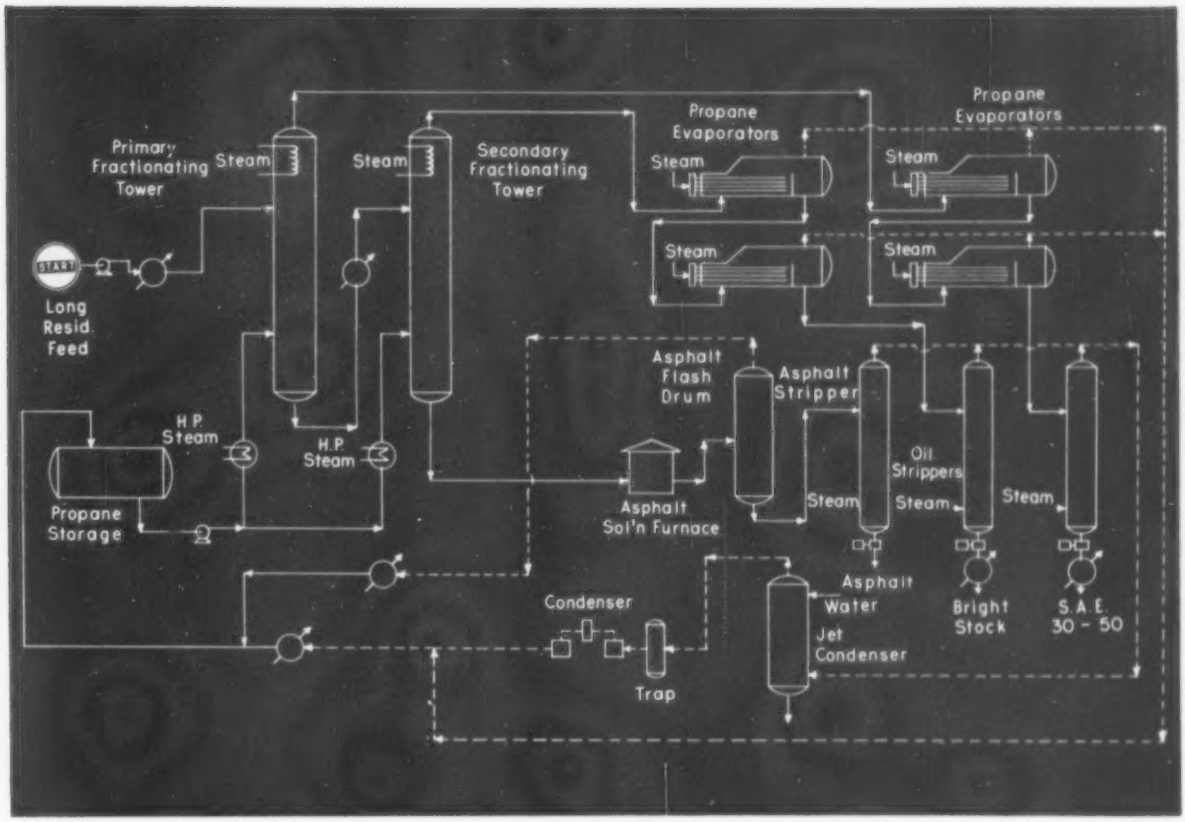
In brief, the product recovery systems comprise steam-heated evaporators operated under sufficient pressure that the vaporized propane can be condensed for re-use with plant cooling water, followed by direct steam strippers held at atmospheric pressure. Only the traces of propane removed in the strippers, plus that vaporized during the chilling operation, require compression.

The simplicity and economy of the process result largely from the fact that a single fluid—ordinary propane—serves as solvent, as diluent, as refrigerant and (in vapor form) as blanketing gas and filter blow-back. In dewaxing oils of varying viscosities, the only solvent adjustment required is the ratio of propane to oil. By merely lowering the pressure of the charge oil-solvent mixture evaporation of solvent occurs with consequent refrigerating effect.

Yields—The following table gives the yields and inspections on four lubricating stocks:

	Propane Deasphalted Phenol Treated 15 Percent E. Texas Reduced Crude	Phenol Treated E. Texas Heavy Distillate	Propane Deasphalted Phenol Treated W. Edmond SAE 70 Stock	Propane Deasphalted Phenol Treated Okla. City SAE 40 Stock
Propane, Volume Percent	300	250	300	300
Filtering Temp., F	—34	—35	—40	—41
Dewaxed Oil Volume Percent	61.6	67.7	85.5	81.1
Inspections Waxy Oil:				
°API Gravity	29.7	32.0	27.4	30.1
SSU Viscosity at 210 F	93.1	57.3	132	72.7
Color ASTM	4½—	2—	3½—	2—
Carbon Residue, Percent	0.20		0.25	0.06
V.G.C.	.795	.790	.803	.797
Dewaxed Oil:				
°API Gravity	27.6	28.9	26.7	28.7
SSU Viscosity at 210 F	118.4	66.2	150.0	79.6
Color ASTM	4½—	2—	3½—	2—
Pour Point, F	0	0	0	—5
Carbon Residue, Percent	0.26	0.03	0.30	0.05
Viscosity Index	95	92.1	91.1	92.1
V.G.C.	.804	.808	.807	.804

Commercial Installations—There are 8 domestic and 6 foreign units in operation.



Propane Fractionation—THE M. W. KELLOGG COMPANY

Application—Propane Fractionation is a development of propane deasphalting in which two or more grades of raw lube stock are segregated by liquid propane extraction.

Charge—Selected long vacuum residua containing both bright-stock and heavy neutral fractions.

Product—Raw heavy neutral and bright stock of distinctly lighter color, lower carbon residue, and higher viscosity index than corresponding fractions from vacuum distillation. Asphalt equivalent to that obtained in propane deasphalting is also produced.

Description—Oil to be fractionated is charged to the primary tower and countercurrently extracted with liquid propane. Steam coils installed in the tower heat the solution to a temperature such that only the heavy neutral is dissolved in the light phase and taken off overhead. The bottoms product contains oil to be subsequently recovered and asphalt.

Primary tower overhead flows in series through two evaporators in which the bulk of the propane is removed at high pressure and returned to the process without compression. After the evaporators, final traces are removed from the neutral product in a steam stripper.

Bottoms from the primary tower are passed to the secondary fractionation tower, where at lower temperature and pressure, propane countercurrently extracts the raw bright stock from the asphalt. Operation of the tower is similar to that of the primary fractionator just described. The oil-propane solution is removed from the top of the tower and passed through two evaporators and a stripper to separate the product from the propane, which is returned to the system.

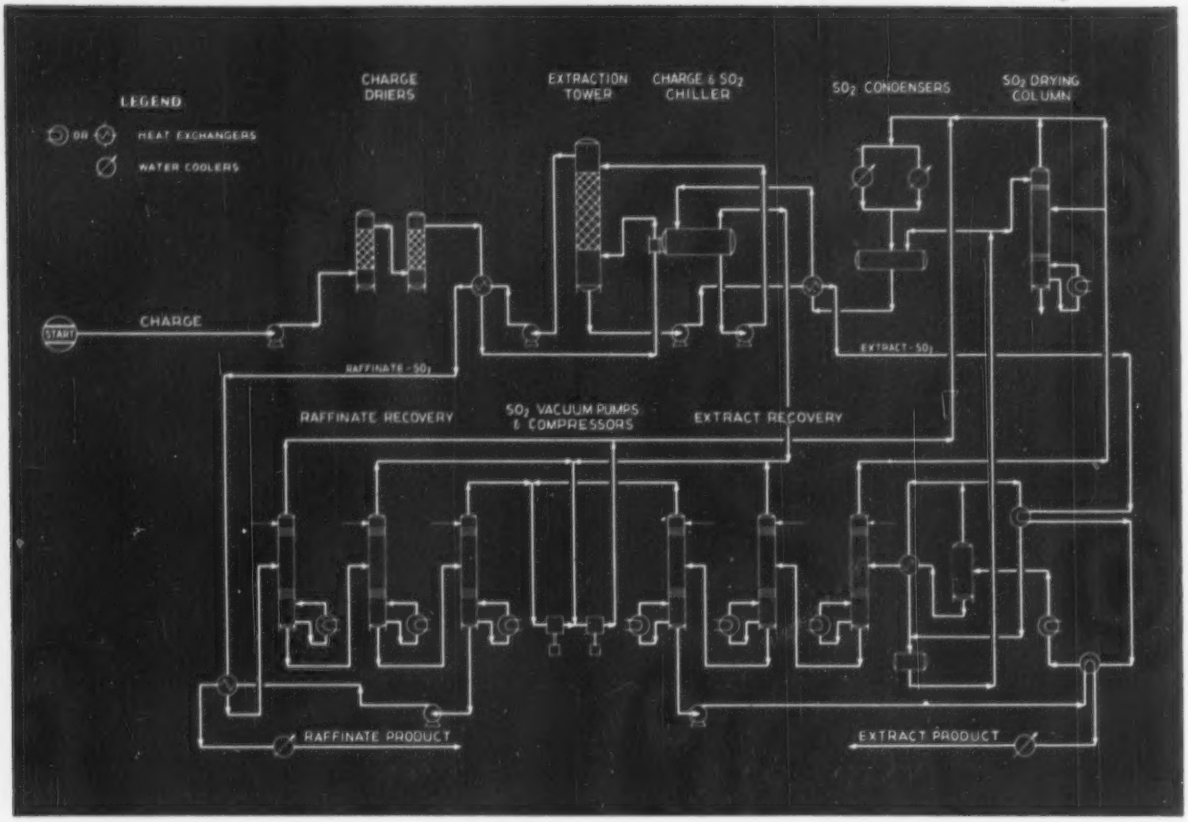
Bottoms from the secondary fractionator are passed first to a furnace and then to a flash drum in which the bulk of the propane is vaporized and separated. Remainder of the propane is removed from the asphalt by steam stripping.

A third fractionation section, designed to operate at a still lower extraction temperature, may be added to the above system to increase the melting point of the final asphalt product and recover a high viscosity "resin" fraction if this is desirable.

Yields—(Comparison of vacuum distillation and propane fractionation.)

	Medium Neut.	Cylinder Stock	Residue
Vacuum Distillation:			
Yield Percent on Crude	13.0		14.3
Position in Crude—Percent	72.7–85.7	Not Produced	85.7–100
Viscosity SSU at 210 F	90.7		6840
Gravity—°API	19.0		7.3
Color—ASTM	5 (D)		
Conradson Carbon—Weight Percent	2.1		21.4
Dewaxed (0°F. Pour Pt.) V.I.	50.2		
Propane Fractionation:			
Yield Percent on Crude	8.6	3.2	11.5
Position in Crude—Percent	76.7–85.3	85.3–88.5	88.5–100
Viscosity SSU at 210 F	94.0	239	
Gravity—°API	24.3	18.0	1.6
Color—ASTM	4½	5	
Conradson Carbon—Weight Percent	0.66	2.6	
Dewaxed (0°F. Pour Pt.) V.I.	80.6		
Softening Pt. (R & B) °F.			130

Commercial Installations—At the present time there is one commercial propane fractionation plant in operation producing two conventional lubricant grades. In addition three propane deresining units refractionate bottoms (below bright stock) into two or more high viscosity resin cuts.



SO_2 Extraction—STONE & WEBSTER ENGINEERING CORPORATION—BADGER PROCESS DIVISION

Application—The SO_2 extraction process is used to remove aromatic hydrocarbons and sulfur bearing compounds from paraffinic and naphthenic hydrocarbons to produce high quality raffinate products. The process can also be used to recover high purity aromatics.

Charge—The fractions range in boiling point from naphtha and catalytic reformates through kerosene, gas oils, cycle oils from catalytic cracking and high and medium lubricating oils. Minor modifications in design permit blocked-in operation for a wide variety of charge stocks.

Product—The extraction of the aromatic hydrocarbons may serve two purposes; the quality of the remaining oil may be upgraded or the aromatic fraction may be the desired product.

Description—The accompanying diagram illustrates the flow in a plant designed for handling stocks ranging from light naphthas to light lube oil distillates.

The charge stock is pumped through a coalescer for the removal of free water and then through a dryer. The charge oil is next cooled by heat exchange with raffinate solution and further by refrigeration with SO_2. It is then introduced into the lower section of the packed extraction tower.

In the extraction tower, the charge oil is contacted with chilled liquid sulfur dioxide and is separated into a refined oil phase and an extract phase. The latter contains most of the SO_2 used for the extraction. The raffinate phase leaves the extraction tower at the top, while the extract phase accumulates in the base section. Both phases are pumped into their respective solvent recovery sections in which the SO_2 contained in the oil is removed in a series of evaporators.

The process consumes liquid sulfur dioxide at the rate of about 0.15-pound per barrel of charge. This loss is due to leakage, venting of the condensers, and incomplete recovery from the products and from the water removed in the drying tower.

Operating Conditions—Extraction temperatures of —20 F. to +60 F. are used, the lower temperatures for platformate and kerosenes and the higher temperatures for high pour point stocks. The high selectivity of SO_2 permits the use of a very low SO_2 treat, 0.62 to 1.65 vol percent of the charge, coupled with a low number of extraction stages, usually 2-5.

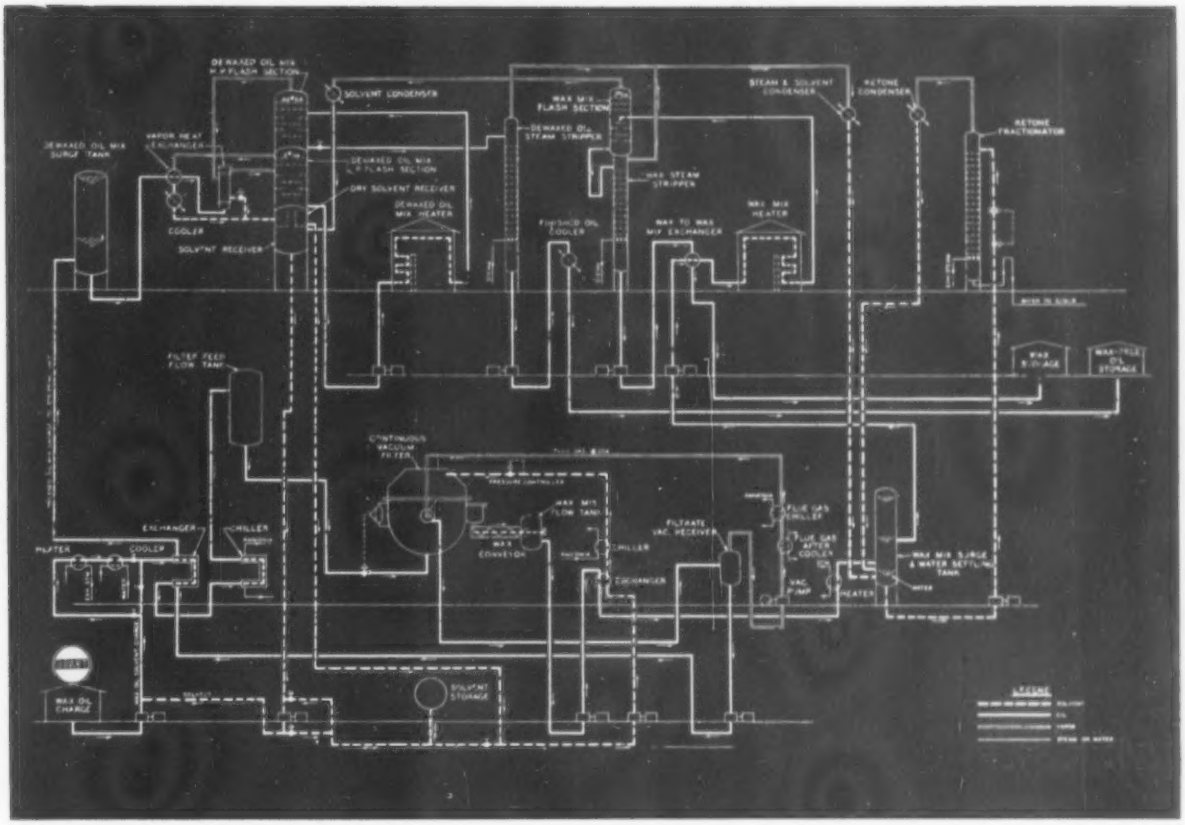
Yields—High purity benzene, toluene and xylenes are extracted from platformates with simultaneous individual aromatic recoveries greater than 97 percent.

Lamp oils are improved to a smoke point of 30-40 with removal of 75-90 percent of the original sulfur and 85-95 percent of the original aromatics present in the feed. Raffinate yields vary from 75-90 percent by volume.

Treatment of gas oils produces raffinates containing 5 percent or less of aromatics and extracts of an aromaticity of 70-80 percent. The process produces premium quality diesel fuels from straight run or cracked stocks. The treatment of catalytic cracking cycle stock reduces the coke laydown in subsequent cracking by 50 percent or more.

Commercial Installations—The total installed charge capacity of SO_2 extraction plants in the U. S. A. and foreign countries is about 200,000 barrels per day. Plants for a total charge capacity of 114,000 barrels per day have been built by the Badger Division of Stone & Webster Engineering Corporation.

Reference—PETROLEUM REFINER, vol 30, no 9, p 237 (Sept, 1951).



Solvent Dewaxing—TEXACO DEVELOPMENT CORPORATION

Application—The process is used for the removal of wax from lubricating oil stocks.

Charge—Either distillate or residual stocks of practically any viscosity in the raw or refined state from any crude source can be dewaxed.

Product—Dewaxed oils with pour points equal to or within a few degrees of the dewaxing temperature.

Description—The accompanying flow diagram shows the flow through the unit. In operation, the dilution solvent is introduced into the wax-bearing oil stream in such amounts at selected points in the chilling cycle as to insure a wax crystal structure and liquid viscosity most suitable for filtration.

The chilled charge mixture flows from the double pipe chillers through a filter feed tank to drum-type vacuum filters in which compartmentized, cloth covered drums rotate, half submerged in enclosed filter cases. A wax-free oil filtrate solution is drawn through the filter cloth to filtrate tanks in which the vacuum, which induces filtration, is maintained. The wax cake deposited upon the drum during filtration is washed with cold solvent as it emerges from the liquid level in the filter. Just before each of the filter drum compartments reaches the wax deflector, flue gas at low pressure is admitted through a blow-back connection to the underneath side of the filter cloth. The bond between wax and cloth is broken and the washed wax falls into the wax discharge compartment. Controllers in the flue gas piping maintain an atmospheric pressure in the filter hood.

The filtrate from the filtrate receiver is pumped through the double pipe exchangers to evaporators for recovery of the solvent. Heat for evaporating the solvent from the dewaxed oil solution and the wax mix may be supplied by either steam or fire heaters.

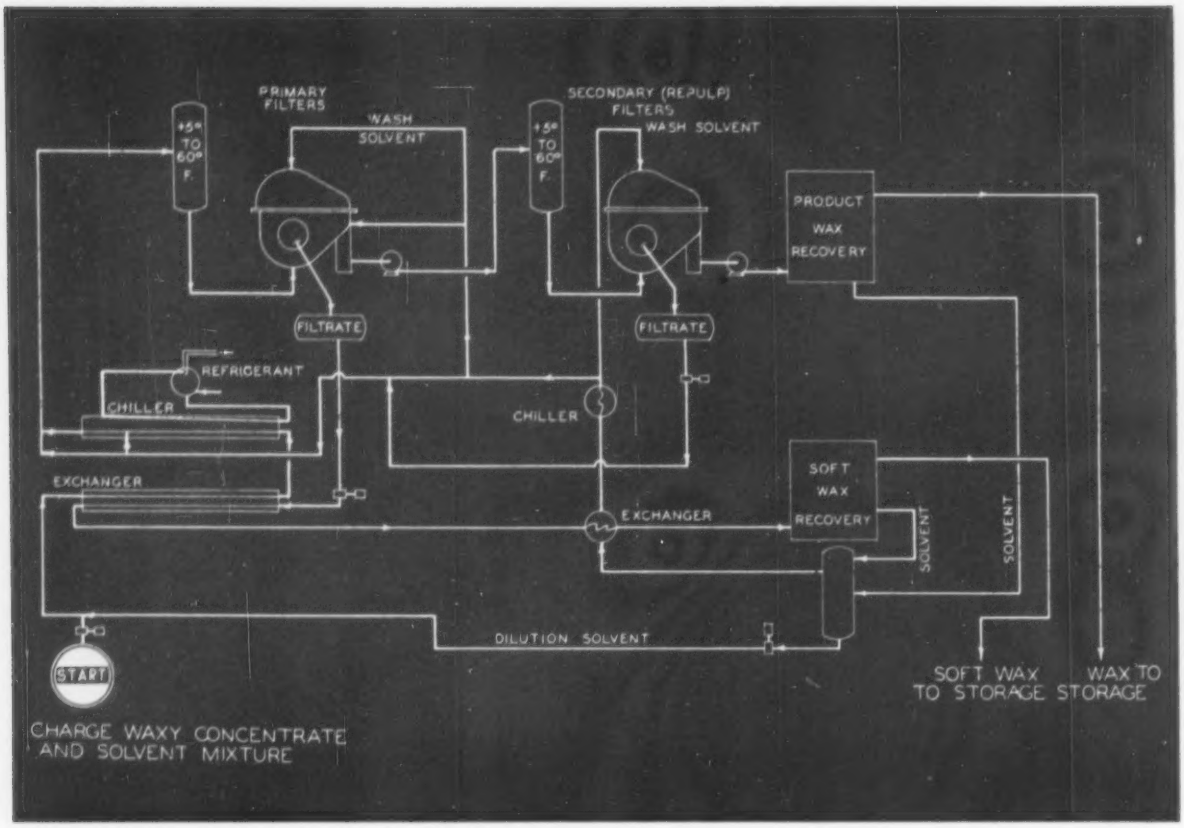
The solvent employed generally consists of a mixture of methyl ethyl ketone and an aromatic solvent (benzol, toluene or a mixture of the two). Because of its relatively low boiling point, the solvent can readily be recovered from the dewaxed oil and wax solutions in simple evaporating equipment for continuous re-use.

Operating Conditions—Dilution solvent dosages vary from a solvent-to-oil ratio of 1.0:1 to as much as 4.0:1 depending on the nature and viscosity of the charge stock. The temperature for dewaxing is dependent upon the desired pour point of the dewaxed oil and is equal to or only a few degrees below the pour point. Low pressures exist throughout the process.

Yields—The yields of dewaxed oil are dependent upon the wax content of the charge stock. Practically complete separation of oil from wax is obtained by the use of the cold displacement wash applied on the filter.

Commercial Installations—The first commercial unit was installed in 1927 and in the intervening time, 72 units have been installed. Two additional units are under contract for construction.

Reference—Petroleum Refiner, vol 15, no 6, p 205 (June 1936).



Wax Fractionation—TEXACO DEVELOPMENT CORPORATION

Application—The process is operated for the production of wax of low oil content.

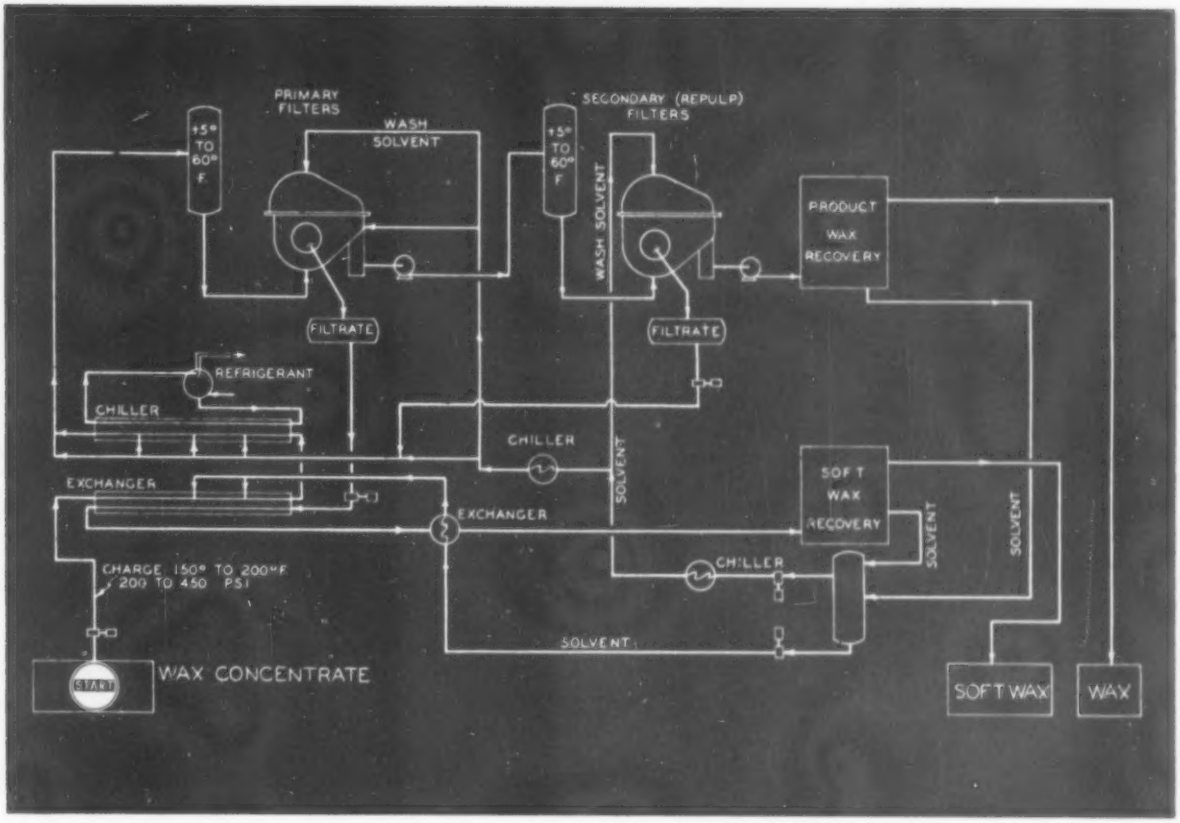
Product—Crystalline and micro-crystalline waxes with melting points depending upon the nature of the charge stock can be produced by this process. Crystalline waxes which consistently show oil contents by ASTM analysis that are below 0.5 percent can be produced. Depending upon the source of the raw waxy concentrate, finished micro-crystalline waxes can be produced which, without additives of any kind, have melting points as high as 200 F. and asphalt penetrations at 77 F. as low as one.

Descriptions—The process employs an operating technique involving the crystallization of wax or a selected portion of the wax contained in a waxy concentrate in the presence of a substantial amount of solvent, added to the charge stock before any of the wax is crystallized. The solid wax is separated from the liquid phase by filtration at a temperature suitable for the desired degree of fractionation.

Typical of the combined operation of the Solvent Dewaxing and Wax Fractionation process is a case in which low pour point dewaxed oil and wax of low oil content are produced concurrently. In the operation, a mixture of the wax-bearing charge stock with a substantial amount of solvent is chilled in double pipe scraped surface chilling equipment to a temperature suitable for the production of dewaxed oil of the desired pour point. The mixture is then filtered and the oil-bearing solution in the wax cake is washed continuously from the wax by displacement with cold solvent. The wax cake is continuously discharged from the primary filters and heated until the wax is totally dissolved in the solvent. Additional warm solvent is blended with the wax cake solution and the mixture cooled in double pipe scraped surface equipment to a predetermined temperature necessary to crystallize the desired wax fractions and obtain the proper quality of wax. The recrystallized wax is then continuously separated by means of a second filter on which the wax receives a final wash. The wax cake from this filter is pumped to the solvent recovery system from which the solvent-free product wax of low oil content is recovered. The filtrate from the secondary filter containing a small amount of oil and undesirable soluble wax fractions is pumped to the solvent recovery system from which the "soft" wax is delivered to storage tanks.

Over-all solvent dosages for a combined dewaxing and wax fractionation operation vary from a solvent-to-oil ratio of approximately 3.5:1 for low viscosity lubricating oil distillate stocks to 9.0:1 or more for viscous residual stocks.

Commercial Installations—Thirty-one commercial installations employ the Wax Fractionation process in the production of high quality waxes.



Wax Manufacturing—TEXACO DEVELOPMENT CORPORATION

Application—The process is operated for the production of oil-free wax.

Product—A full range of waxes with melting points from below 120 to above 170 F., depending upon the nature of the charge stock, can be produced. Crystalline waxes consistently show oil contents by ASTM analysis that are below 0.3 percent and with certain types of crystalline waxes below 0.1 percent.

Description—The process is characterized by an operating technique involving the crystallization of wax or a selected portion of the wax contained in the petroleum oil or waxy concentrate by first cooling in the absence of solvent or in the presence of a limited and carefully controlled amount of solvent; then adding solvent in small increments until all of the desired wax types have crystallized. Sufficient cold solvent is then added to the cooled waxy slurry to permit separation of the solid wax from the liquid phase by filtration.

Typical of the combined operation of the Solvent Dewaxing and Wax Manufacturing process is a case in which low pour point dewaxed oil and wax, that for practical purposes is oil-free, are produced concurrently. In this operation, the wax-bearing charge stock is cooled without dilution solvent. After the wax has started crystallizing, a small amount of solvent is added; chilling of the mix is continued and as more wax crystallizes, small proportions of solvent are added as necessary. When the temperature required for the production of 0 F. pour point dewaxed oil is reached, a final amount of solvent is added to bring the mixture to the proper filtering viscosity. The mixture is then filtered and oil in the wax cake is washed continuously from the wax by displacement with cold solvent. The total wax cake is continuously removed from the filter and additional solvent mixed or repulped with the wax slurry at a temperature necessary to retain any remaining oil and low melting point, undesirable wax fractions in solution. The repulped slurry is then continuously filtered on a second filter on which the final wax is again washed. The cake from this filter is pumped to the solvent recovery system from which an oil-free product wax is delivered to storage. The filtrate from the secondary filter containing a small amount of oil and undesirable soluble wax fractions is transferred to the solvent recovery equipment from which the "soft" waxes are delivered to storage. The recovered solvent is continuously returned to the system for re-use.

Over-all solvent dosages for both the dewaxing and wax manufacturing operations vary from a solvent-to-oil ratio of approximately 2.5:1 for low viscosity distillates to 7.0:1 for viscous stocks containing micro-crystalline waxes.

Commercial Installations—Seven installations of the Wax Manufacturing process have been made for the production of high quality waxes. Two additional units are under contract for construction.

Reference—*The Oil and Gas Journal*, vol 40, no 46, p 98 (Mar. 25, 1943).

Treating

TREATING PROCESSES are essential to petroleum refining, although they have an accessory relation to the basic scheme of converting crude oils to gasolines and fuels. Treating is used to make feed stocks suitable for processing to their best advantage, and it finishes products to meet quality standards. As quality requirements become more stringent, investment in equipment and efforts devoted to operating and maintaining such processes reach sizable proportions.

Crude desalting is a treating method employed at the very beginning of a crude processing scheme. The large majority of crudes are contaminated with salt water, either as an emulsion with the oil or in free form. Desalting processes are employed to remove this contaminate. If the emulsified oil were charged to crude stills without treatment, it could reduce throughput drastically and cause costly corrosion problems.

The desalting processes may be classified as mechanical, chemical or electrical. Most of the processes mix the crude with water to get the salt accumulated in the aqueous phase. Chemical or electrical means are used, then, to speed separation of the salty water from the crude.

Visco Products Company, Inc., Houston, Texas, and Tretolite Company, St. Louis, Missouri, are manufacturers who supply chemicals for desalting. Two companies which furnish electrical desalting processes are Petrolite Corporation, St. Louis, and Howe-Baker Corporation, Houston.

Caustic washing is a widely used means of treating gasoline products for removal of hydrogen sulfide and mercaptans. These substances impart a bad odor to the gasoline and tend to cause gum and color formation. The caustic removes these substances by reacting with them to form sodium salts. The salts remain in the caustic so that the solution must be discarded occasionally or regenerated.

Several processes use additional compounds in the caustic solution to promote reaction of the solution with the mercaptans. Dualayer, Mercapsol, and Solutizer processes use acid oils and phenolic materials for this purpose. Unisol uses methanol to improve extraction.

Regeneration systems are part of the foregoing processes. They remove from the caustic the mercaptans and acidic materials which accumulate there. Other processes which are designed for caustic regeneration are: ADC Ferrocyanide Treating and Electrolytic Mercaptan.

Some processes are designed to handle those situations where the caustic or other treating solution is reluctant to separate from the product. These are Electrical Distillate Treating and Electrofining.

It is not required that mercaptans be removed from gasoline for the product to be "sweet." The mercaptans may, instead, be converted to the less objectionable disulfides. Bender and Doctor Sweetening are examples of processes which convert mercaptans.

And now, Hydrodesulfurization is fast becoming a major means of removing sulfur compounds and other objectionable materials from refinery streams. A comprehensive review of this type of treating is given in the feature article which follows the Process Handbook section. The reader is referred to this report on "What Hydrogen Treating Can Do," starting on P 306.

Gas treating may be practiced with such processes as Girbotol or Glycol Amine Gas Treating. They are employed usually to remove sulfur from gases charged to polymerization units.

Percolation Filtration and Continuous Contact Filtration are two processes for improving color and odor of lube oils. The first contacts the oil in a fixed bed of absorbent. Regeneration is done in place. In the latter process, the absorbent is added to the charge to form a slurry which passes through the system. Afterward, the absorbent is dropped out of the stream and is regenerated.

Additives are a form of treating which is not represented in this handbook.

Deactivators are used to tie up copper compounds so that they will not affect the gum and color stability of a product. Other additives promote oxidation of mercaptans to disulfides, and these are used to replace the more expensive sweetening processes.

Other Processes

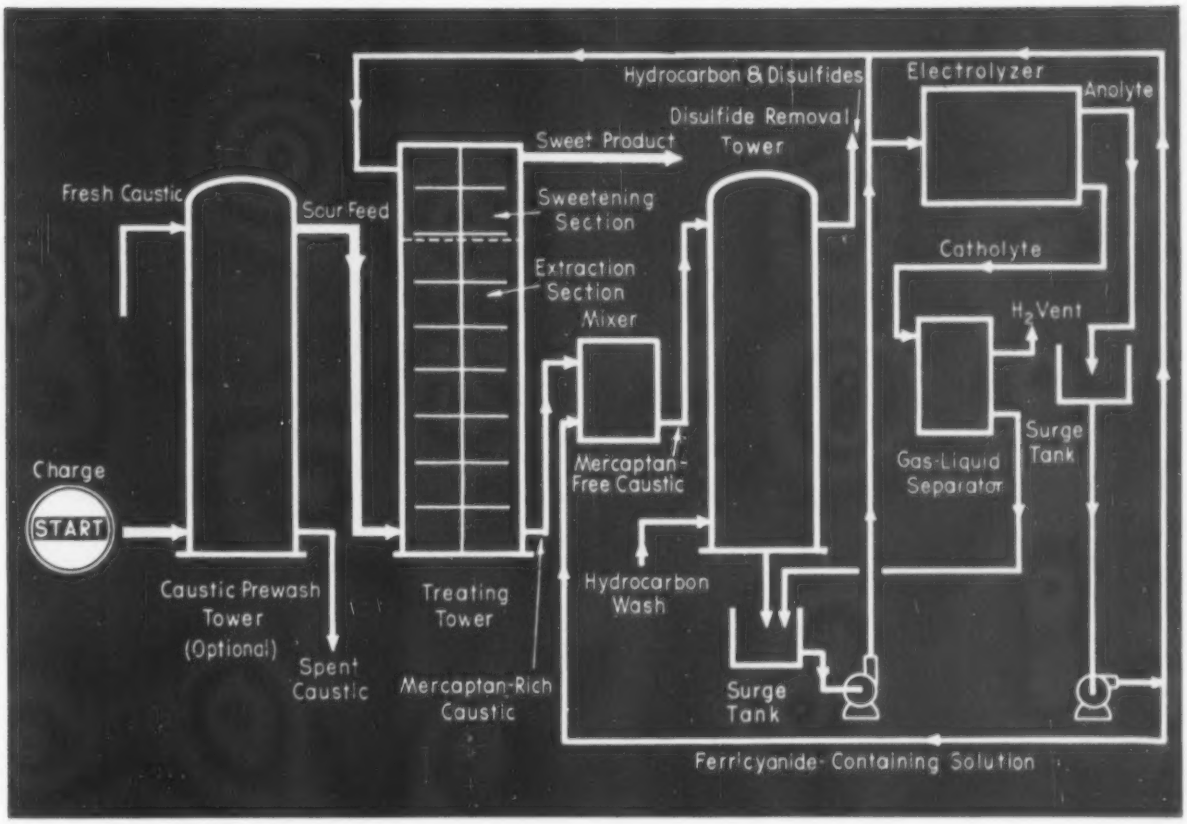
ALONG WITH THE necessity of converting crudes and gases into products, there is the need also to separate and recover hydrocarbons as they already exist in a refinery crude or field stream. As there are many variations of these processes, only a few are represented here.

Crude distillation is a fundamental operation in any refinery. It is important primarily because it is the simple separation of a crude charge into discrete components. This often is the step for preparing a charge for subsequent refining steps. Two such operations are represented —Crude Distillation for Maximum Cracking Feed and Crude Distillation for Maximum Lubes.

Light hydrocarbon recovery is required within a refinery to get maximum utilization of gaseous materials. Many of the operations, which were first employed only in natural gasoline plants, found their way into everyday refinery use. Now both factions of the petroleum industry are equally interested in these techniques.

Cracking and reforming processes produce large quantities of gas so that it is uneconomical to burn this material in furnaces, as was done in the past. Furthermore, these cracked and reformed gases are more valuable if they are separated into fractions for special processing.

Petrochemicals are getting a growing portion of the chemical market. Because of this great interest in petrochemicals, the processes which deal with their production are combined in a separate handbook. The reader is referred to our last publication of the Petrochemical Handbook which appeared in the December, 1955 issue of the PETROLEUM REFINER.



ADC Ferrocyanide Treating— AMERICAN DEVELOPMENT CORPORATION

Application—The process extracts mercaptans from gasolines or other light hydrocarbons, sweetens the products, or combines extraction and sweetening.

Charge—Gasoline or other light hydrocarbons, including LPG, natural gasoline, poly feed stocks, etc.

Product—Either a doctor sweet product, or one from which the mercaptans have been substantially removed.

Description—The process is based on three discoveries:

1. Low concentration of ferricyanide in strong alkaline solutions is a sufficiently powerful oxidizing agent to convert dissolved mercaptans to disulfides. This accounts for the excellent regeneration of spent caustic soda.

2. Light hydrocarbons are completely sweetened by a caustic soda solution containing an excess of dissolved ferricyanide. This step is employed if a doctor sweet product is desired.

3. Excellent regeneration of sodium ferrocyanide to ferricyanide can be accomplished at high efficiency in a specially designed electrolytic cell.

Following the removal of any H_2S or acid oils by a precaustic wash, the charge stock is introduced into one end of an extractor, preferably one that employs internal mixing, counter current to a ferrocyanide-containing caustic solution. Since the caustic is mercaptan free, due to the excellent regeneration, it effectively removes mercaptans from the hydrocarbons.

The resulting mercaptan-rich caustic is regenerated in the mixer by intimate mixing with caustic soda containing some ferricyanide. Proportioning is so arranged that complete conversion of mercaptides to disulfides is achieved irrespective of the mercaptan concentration of the solution. The solution leaving the mixer is scrubbed for the removal of the disulfides.

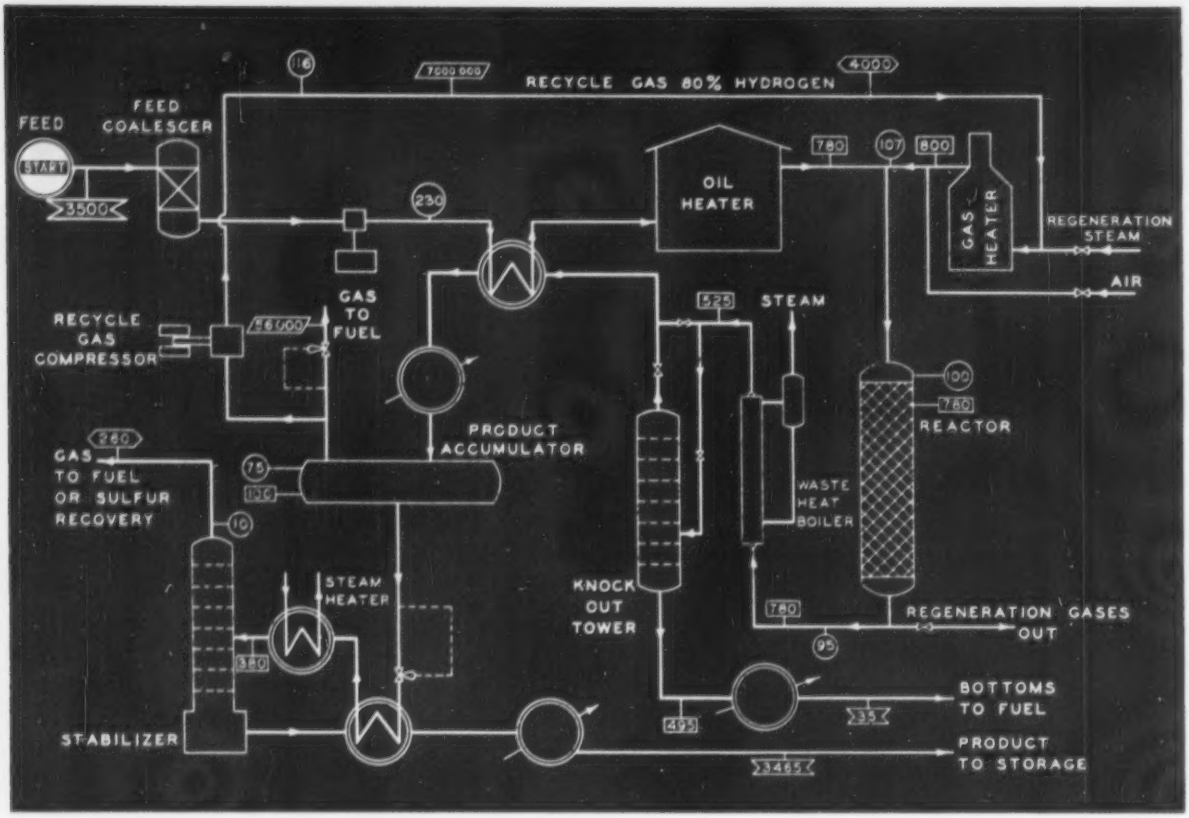
The regenerated disulfide-free alkali is divided into two streams, one being recycled to the mercaptan extractor, the other to an electrolytic cell where conversion of ferrocyanide to ferricyanide occurs.

If a doctor sweet product is required, the alkali solution spiked with ferricyanide contacts the hydrocarbons in an additional stage, or section of the extractor. This converts the remaining mercaptans to disulfides, with a resultant sweet hydrocarbon product. The sweetening can be performed, with or without concurrent extraction of mercaptans, dependent on the economics of the case.

The solution used in the process usually contains 12 percent of NaOH plus 35 grams per liter of sodium ferrocyanide decahydrate. The ferrocyanide is a readily available innocuous compound which sells for about 15c per pound. The chemical cost is negligible since the process is completely cyclic.

Commercial Installations—There are no commercial installations at the present time.

Reference—Petroleum Refiner, vol 34, no 9, p 155 (Sept, 1955).



Autofining—THE BRITISH PETROLEUM COMPANY, LTD.

Application—Autofining catalytically desulfurizes distillate feeds without requiring an external source of hydrogen.

Charge—Straight-run distillates up to 700 F. end point also aromatic extracts and blends with cracked distillates.

Product—With almost complete desulfurization the light products show an increase of 2-4 octane numbers (clear) and a greatly increased lead response.

Description—The accompanying flow diagram is that of an Autofining unit designed to handle solvent naphthas and power kerosines. The feedstock and the recycle gases are vaporized and heated in separate heaters and pass downward through the reactor. The hot vapors from the reactor pass through a waste heat boiler, where steam is generated; after heat exchange and cooling, the products flow to the separator from which the recycle compressor takes suction. If it is desired to meet a color specification with products such as power kerosines, the products leaving the waste heat boiler pass into the knock out tower where 1 to 2 percent volume of heavy ends are removed. Any excess gas make is passed to fuel from the product separator. Liquid product from the separator passes to a flash tower stabilizer to remove the hydrogen sulfide and other gases, which results in flash point rectification. The stabilizer product is normally free of hydrogen sulfide but a light caustic soda wash may be advisable to guard against poor stabilizer operation.

Granular (2 to 4 mesh) or pelleted catalyst is used and a life of over four years has been obtained. Regeneration of the catalyst can be readily accomplished by air/steam or inert gas/air mixtures when the full activity of the catalyst can be restored.

Operating Conditions—The usual operating temperature range 750-800 F. Pressures may be held at 100-200 psig by venting excess recycle gas, or allowed to reach equilibrium in the system when the pressure may rise to 600 psig.

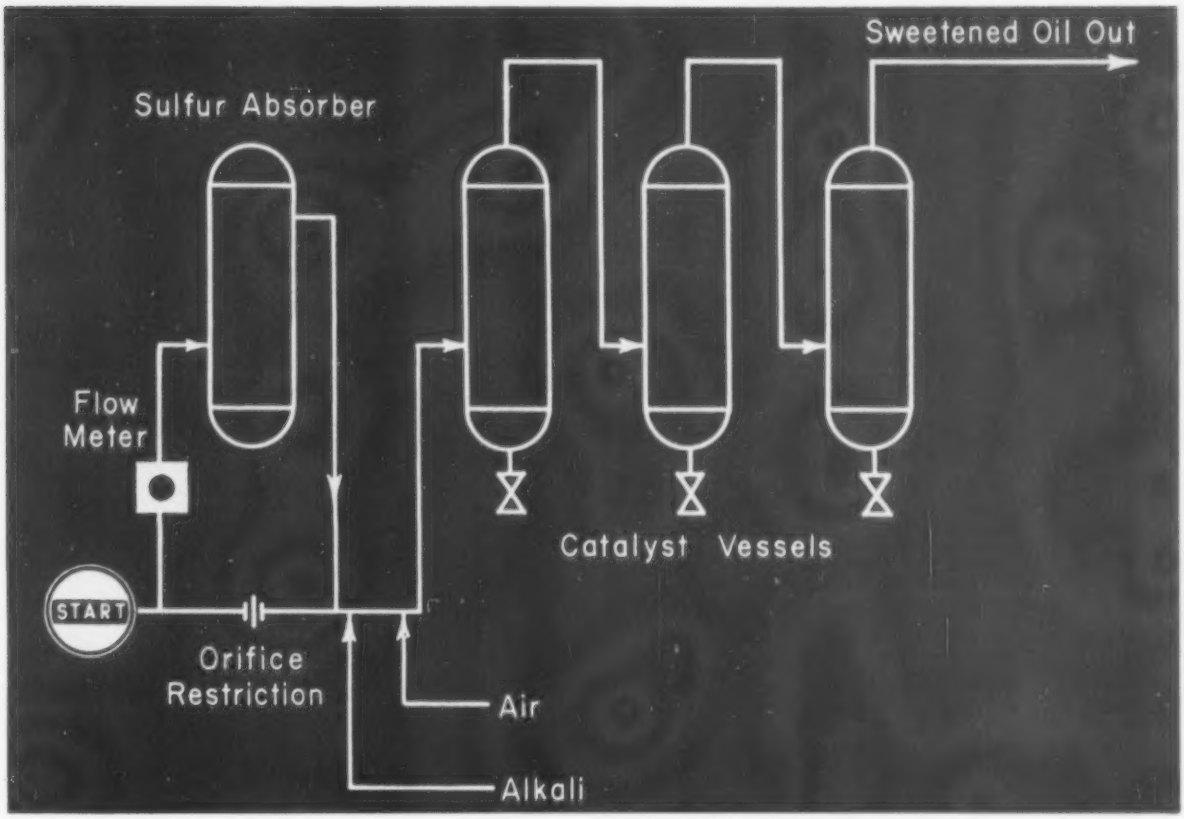
Yields—Typical yields and properties when operating on Middle East feedstock are shown in the following table.

	Power Kerosine*		Straight-Run Gas Oil	
Method of Operation	**Constant Pressure (100 psig.)**		**Equilibrium Pressure (500 psig.)**	
Yield:				
(Weight Percent on Feed)	99.0		96.0†	
Sulfur Removal Percent	70.0		92.0	
	Feed	**Product**	**Feed**	**Product**
°API at 60 F	39.6	40.2	36.3	38.0
I.B.P., F	284	291	482	360
E.P., F	502	500	684	671
Percent Sulfur	0.8	0.24	1.25	0.1
Octane Rating (F2) Clear	52	53	.....	.....
Diesel Index	.....	.....	60	60

† 1.4 Percent Weight Light Ends not Included. * Including 10 Percent Cat Cracked Component.

Commercial Installations—The initial plant built in 1948 at the BP Grangemouth Refinery, Scotland, has been increased to a 500-barrel-a-day unit, and 3500-barrel-a-day units are also in operation in BP's refineries at Llandarcy, Wales, and at Aden.

Reference—Petroleum Refiner, vol 32, no 12, p 84 (Dec, 1953).



Bender—PETRECO DIVISION, PETROLITE CORPORATION

Application—The Bender Process sweetens distillates, and is particularly applicable for the reduction of mercaptan sulfur in the range of 0.02 to .035 weight percent.

Charge—Distillate streams such as gasoline, kerosine, jet fuel, No. 2 fuel oil. It is especially effective in the kerosine-No. 2 fuel oil range.

Product—A sweet, bright, non-corrosive distillate.

Description—In the Bender process sweetening is accomplished by converting mercaptans to disulphides in the presence of a fixed bed catalyst. Sulfur is added to the distillate, plus a small amount of alkali (caustic or ammonia) and air. This mixture is then passed over a bed of solid catalyst.

The distillate passes through the catalyst bed rapidly, at rates up to 12 inches per minute. The amount of sulfur required ranges from ½ to 2 of theoretical sulfur equivalents. A small amount of caustic is added to the distillate to maintain the effluent in a slightly alkaline state. Air requirements are moderate; and may be supplied from instrument air systems for smaller distillate streams.

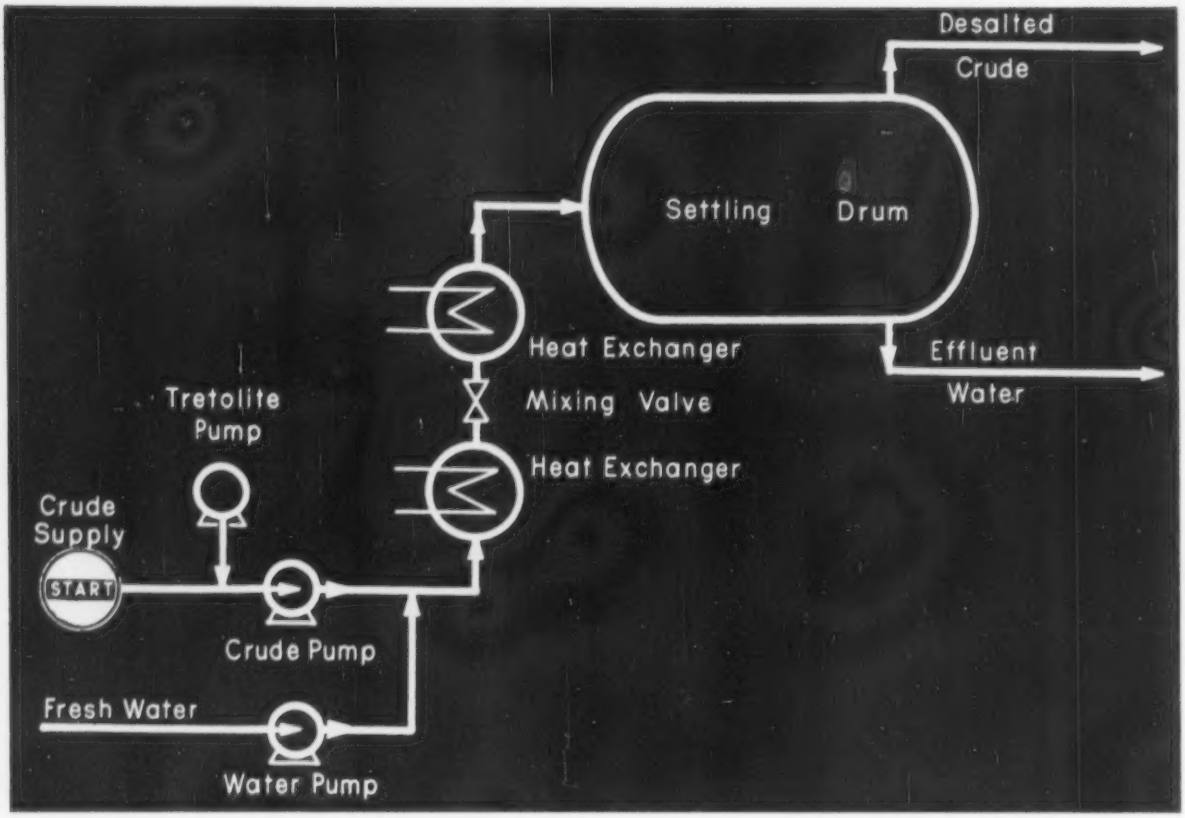
There is no loss in the system, other than sampling and spillage. Regeneration of catalyst is required infrequently. Operation is simple and only minimum operating attention is necessary. Catalyst life will vary, usually being 12 months or more. Rejuvenation of the catalyst can be accomplished economically and promptly at the plant site.

Operating Conditions—Hydrogen sulfide must be removed from a distillate prior to Bender Sweetening to maintain the catalyst activity. Caustic required for neutralization can be introduced in the flow lines between the still and the Bender plant with a knockout drum between. The sulfur required ranges from ½ to ¾ of theoretical for fractions in the gasoline-kerosine range and 1 to 2 of theoretical for fractions in the jet fuel-No. 2 fuel range.

Economics—Installation costs for this process are estimated to be in the range of $10 to $20 per barrel per day of throughput. Chemical costs will run around 0.5 cents per barrel.

Commercial Installations—The Bender process has been used by Sinclair and its affiliates for some time, but now Petreco has been designated as exclusive sublicensors so that the process is available to the entire industry.

Reference—Petroleum Refiner, vol 34, no 9, p 182 (Sept, 1955).



Chemical Desalting—TRETOLITE COMPANY DIVISION, PETROLITE CORPORATION

Application—Present day desalting systems, though originally designed to remove salt from crude oils, now are also judged by their effectiveness in removing other contaminants such as arsenic, trace metals, etc. The removal of these objectionable contaminants by water-washing is primarily dependent on the water solubility or water dispersibility of such contaminants. The state of existence of these contaminants determines the degree of reduction or removal. Usually when these are present as inorganic compounds, a process such as Tretolite Chemical Desalting, employing a wash-water of relatively high alkalinity value (8.0 to 9.0 pH) is generally most effective for removing these from the crude.

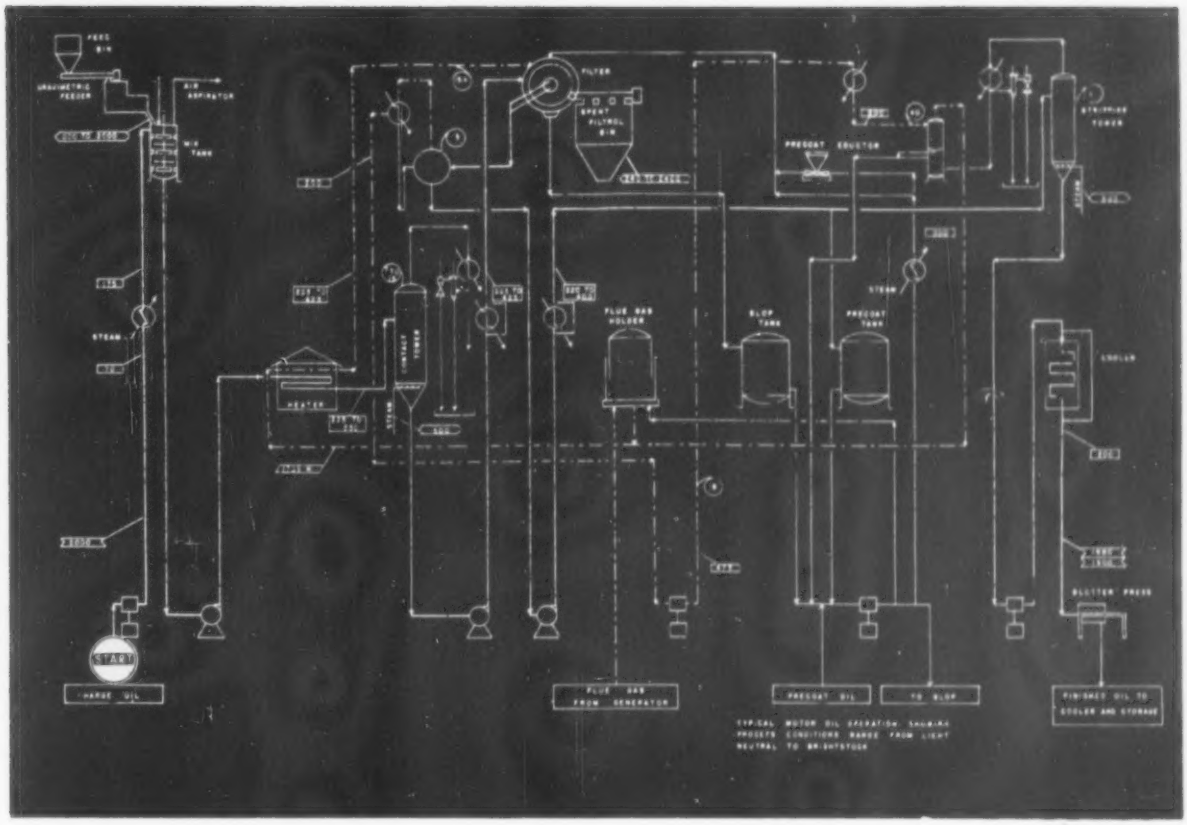
Charge—Crudes varying from 16 to 50 API gravity are being processed through Tretolite units varying in size of from 1000 to 65,000 barrels per day per unit. Salt removal percentages for these various crudes average between 95 and 100 percent with many units continuously removing all of the salt. The average Tretolite chemical cost for desalted crude is 2.0 mills per barrel.

Description—Tretolite Chemical Desalting is accomplished in the following manner: The required amount of Tret-O-lite desalting chemical, determined by preliminary laboratory testing, is proportioned into the suction line of the crude charge pump. This assures complete dispersion of the chemical into the oil. Fresh wash-water, generally 5 percent of the crude oil volume, is introduced following the crude charge pump. The mixture is then preheated and elevated to operating temperature. When additional water-to-oil contact is required for securing optimum desalting efficiency, an emulsifying valve may be located following an exchanger. The emulsion, thus formed, then passes through a Tretolite coalescing section, to promote particle growth in the water phase; then enters the desalting vessel which provides additional crude washing and oil residence time. The salt-free crude then flows directly to the still.

All crudes do not exhibit similar destabilization characteristics. Some separate into the two liquid phases rapidly while others require longer oil residence time in the vessel. For these reasons, Tretolite units are designed to use either single or dual drum systems.

TYPICAL OPERATING CONDITIONS AND YIELDS

Thru-Put Bbls./Day	Crude Type	API Gravity	Percent Wash-Water	Operating		Average Salt PTB		Average Percent Removal	Chemical Cost/Bbl. (Mills)
				Temp. F	Pressure psig	In	Out		
42,000	Devonian	35	5.0	250	175	75	2	97.5	1.0
50,000	East Texas	42	4.8	210	200	60	3	90.0	1.1
25,000	West Texas	35	5.0	220	100	50	3	89.0	1.1
30,000	Venezuela	36	5.0	230	200	50	2	91.0	1.5
22,000	Heidelberg	21	7.5	300	175	120	2	95.0	3.0
16,000	East Texas	38	5.0	200	125	50	2	91.0	1.5
15,000	Illinois—Mid-Continent	35	6.0	195	100	60	1	98.0	0.75
23,000	Wyoming	28	7.0	190	75	50	½	99.0	1.0
22,000	Redwater-Leduc	36	5.0	195	200	75	2	97.0	2.0
35,000	Arabian	34	5.0	220	125	25	2	92.0	0.7
15,000	Oficina-Willimar	33	5.0	180	125	75	3	91.0	1.1
25,000	Oklahoma-Kansas	37	5.0	200	150	40	3	92.0	2.1
50,000	Mid-Continent Mix	42	6.0	250	200	30	½	97.0	2.0
5,000	Michigan	37	5.0	175	125	100	2	98.0	1.8
5,000	Pennsylvania	43	5.0	200	200	40	½	98.0	1.8



Continuous Contact Filtration—FILTROL CORPORATION

Application—The principal application for this process is the refining of lubricating oil stocks, but it is also applied successfully to the finishing of waxes and specialty oils.

Charge—Petroleum hydrocarbons in the lubricating oil or specialty oil range that have been solvent extracted, acid treated or simply distilled. Solvent extracted stocks are dewaxed, usually, before charging.

Product—Finished lube oil or specialty oil base stocks ready for blending and compounding.

Description—The flow diagram shows the operating conditions (minimum and maximum) for a hypothetical unit processing motor oil base stocks ranging in viscosity from light neutrals to bright stocks at an average rate of 2000 barrels per day. Larger and smaller feed rates are employed also.

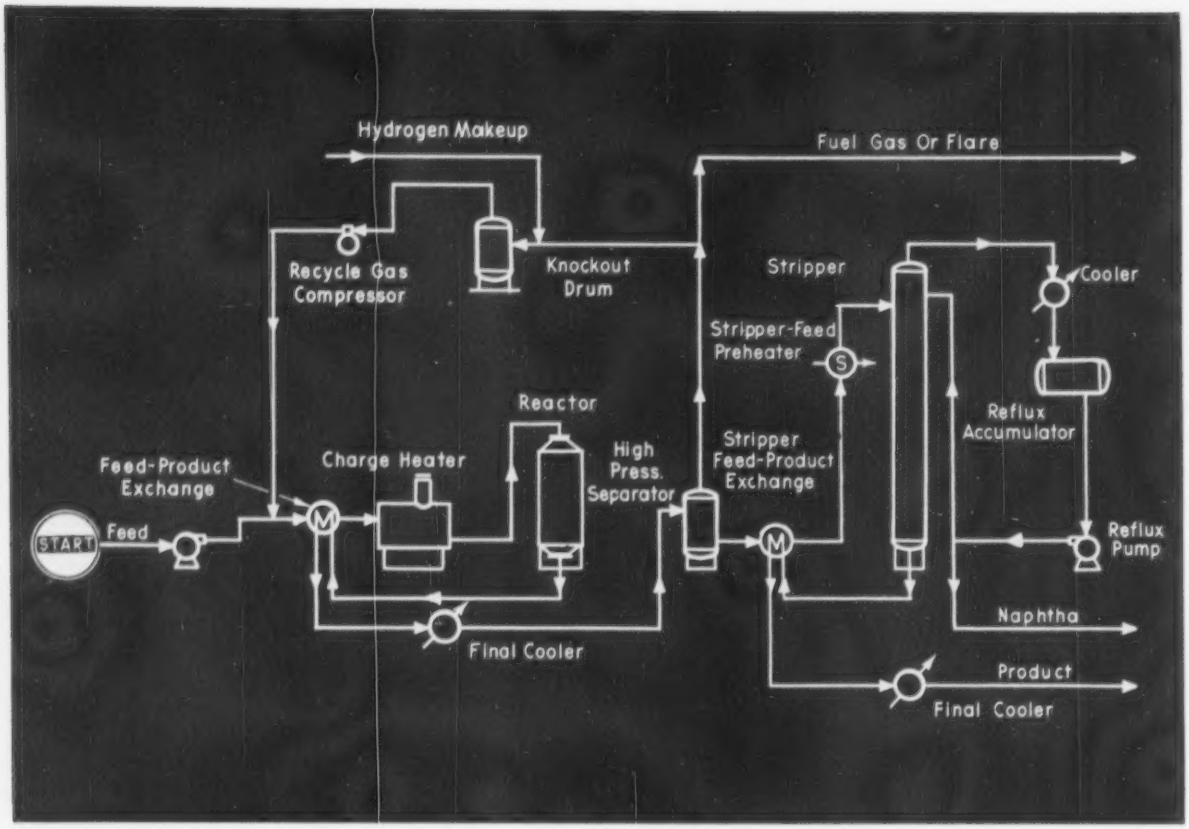
The adsorbent is added to the oil charge and the oil-adsorbent slurry enters a pipe still heater where maximum contact temperature is obtained in a once through operation. From the heater the slurry enters a baffled stripping tower where a level is maintained regulating the time of contact. Steam is passed through the slurry and up the tower to facilitate the stripping action. The slurry is drawn continuously from the bottom of the tower and cooled before being fed to a vacuum filter. The filtered oil is charged to a high vacuum stripper to furnish additional product control. The oil is finally pumped through a blotter press, cooler and to storage.

Yields—Yields are a function of the type of oil charged and the quantity of adsorbent used. Normally, yield approximates 98.5 percent of oil charged.

Contact filtration is a mild refining step, polishing and decolorizing the oil and improving inspections such as carbon residue, oxidation, neutralization number and emulsibility-demulsibility.

Typical Inspections of Lubricating Oils

	Turbine Oil		Phenol Raffinate	
	Before Contact Filtration	After Contact Filtration	Before Acid Tr. and Cont. Filt.	After Acid Treatment and Cont. Filt.
Gravity, API	23.9	23.1	22.6	22.6
Color, ASTM	3	2	4	1½
Viscosity S.S.U. @ 100 F.	508	495	372	364
Flash, °F.	395	410	395	400
Fire, °F.	445	450	440	440
Neutral No.	0.03	0.02	0.9	0.06
Steam Emulsion No.	460	35	.....	.....
Conradson Carbon Residue	.....	.....	0.03	0.02



Diesulforming—HUSKY OIL COMPANY

Application—Diesulforming is a hydrogen treating process that reduces sulfur content of the feed stock. The process also removes nitrogen and oxygen and provides additional advantages of color, odor and cetane improvement.

Charge—The feed stocks which can be processed vary from gasolines to vacuum distillates. Either cracked or straight run are adaptable. Two commercial units now are operating on high sulfur straight run distillate fuels. Table I gives typical inspection data of both the feed and product materials.

Description—The accompanying diagram shows how the Diesulformer must be closely integrated with a catalytic reformer or other source of necessary hydrogen. In this case the distillate feed stock and hydrogen recycle are preheated by exchange with the catalyst reactor effluent before being brought to the reaction temperature in a gas-fired heater. The combined feed and recycle mixture passes down through the fixed bed catalyst reactor where the desired reactions take place. After passing through the charge heat exchanger, the reactor effluent is water cooled and goes to the separator where the liquid product is separated from the recycle gas stream which is recirculated by means of a compressor. Make-up hydrogen is introduced in the suction side of this compressor.

The liquid from the flash drum is stripped of hydrogen sulfide and any low flash constituents. The bottom product from the stripper is a sweet desulfurized distillate that is ready for market. The small volume of H_2S-saturated naphtha recovered from the stripper overhead boils in the gasoline range and can be treated like any other sour gasoline.

Materials of construction of the Diesulformer must be adequate to resist attack of hydrogen and hydrogen sulfide. Lower concentrations of chromium and molybdenum are effective in preventing hydrogen damage, but certain parts of the plant require high chromium content steels to withstand the attack of hydrogen sulfide.

The catalyst can be regenerated in place by burning off contaminants if it becomes necessary. The catalyst used in Diesulforming has maintained its activity very well. Under normal operating conditions, the catalyst is expected to last indefinitely.

Temperature and space velocity are the important process variables. Desulfurization is directly proportional to the temperature and inversely proportional to the space velocity. Secondary variables such as pressure, purity of hydrogen, and recycle rate are interrelated.

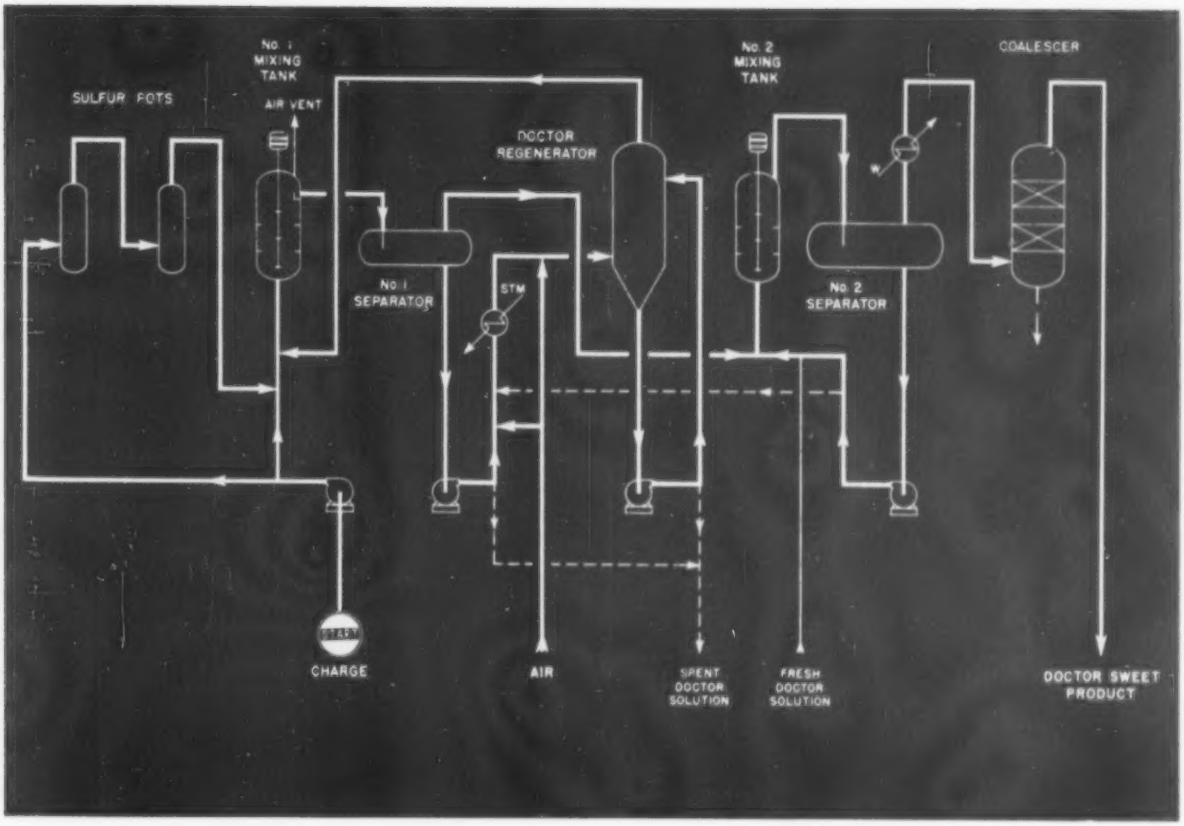
Yields and Operating Conditions:

Space Velocity, Gas Recycle, Lb. Oil per Lb. Catalyst per Hour	1-2
SCF/Bbl. of Charge	5000
Pressure, psig	300-500
Temperature, °F.	600-800

	Med. Dist.		Light Dist.	
	Charge	Product	Charge	Product
Liquid Yield, Vol. %	100	100.1	100	100.2
H_2 Consumption SCF/Bbl.	—	150	—	92
Per Cent S Total	2.2	0.35	1.02	0.1
API	30.2	33.2	39.2	40.6
Distillation:				
Ini.	473	415	379	363
10%	516	512	408	393
50%	570	564	440	432
90%	624	617	495	488
E.P.	656	658	533	545
Flash	230	152	154	147
Aniline Point, °F.	142	152	136	143
Pour, °F.	5	5	—50	—50
Doctor	—	—	DNP	Pass
Odor	Poor	Good	Poor	Good
Cetane	48	58	45	47

Commercial Installation—The first commercial installation was made in the U. S. in 1953 at the Husky Oil Company refinery in Cody, Wyoming.

Reference—Petroleum Refiner, vol 34, no 9, p 158 (Sept, 1955).



Doctor Sweetening—THE LUMMUS COMPANY

Application—The process is employed to sweeten gasoline, solvents, and kerosine by converting mercaptans to disulfides.

Charge—Sour hydrocarbon stocks including gasoline, solvents and kerosine.

Description—Doctor sweetening, one of the oldest processes for sweetening gasoline, solvents and kerosine, converts mercaptans to disulfides using sodium plumbite and sulfur,

$$2\,RSH + Na_2PbO_2 \rightarrow PbR_2S_2 + 2NaOH$$
$$PbR_2S_2 + S \rightarrow PbS + RSSR$$

The PbS is converted back to Na_2PbO_2 by air blowing in caustic soda.

$$PbS + SO_2 + 4NaOH \rightarrow Na_2PbO_2 + 2H_2O + Na_2SO_3$$

In this process, sulfur and caustic soda are consumed. In addition, some PbO is mechanically lost and some must be added to replace solution discarded because of the accumulation of sodium sulfate and sodium salts of cresols and aliphatic acids.

In this unit, a slipstream from the charge stream passes through sulfur pots, and rejoins the main charge stream along with regenerated doctor solution and regeneration air at the bottom of the No. 1 doctor mixer. The sour charge, sulfur solution and regenerated doctor solution are intimately mixed in the No. 1 doctor mixer. Air is vented from the top of this mixer, and the treated charge plus doctor solution flow out through a side nozzle to the No. 1 doctor separator.

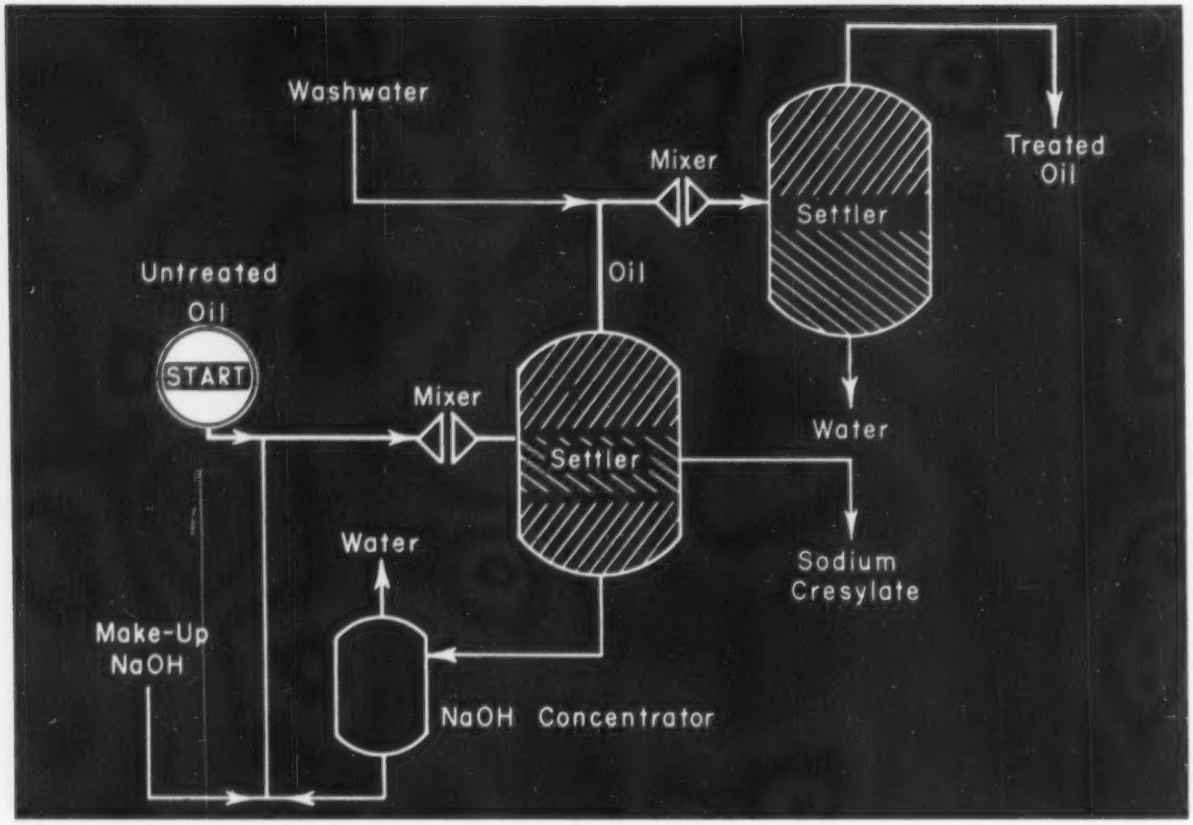
The hydrocarbon stream leaving this separator is combined with second stage doctor solution and mixed in the No. 2 doctor mixer, and then enters the No. 2 doctor separator where most of the doctor solution and lead sulfide formed in the sweetening reaction settle out.

The sweetened stock leaving the No. 2 separator is cooled in the product cooler and passes through the coalescer where residual doctor solution and lead sulfide are removed. Doctor solution from the No. 1 separator is normally circulated through the doctor heater and regenerator, combined with the regeneration air, and delivered back to the No. 1 mixer.

Doctor solution from the No. 2 doctor separator is normally returned directly to the No. 2 mixer. Periodically this solution is pumped forward to the No. 1 mixer and replaced with fresh doctor solution from storage. When this is done an equal volume of spent solution from the No. 1 separator is discarded.

Doctor solution is continuously circulated from the bottom of the regenerator to a nozzle located in the side of the regenerator by means of the doctor pump. This circulation prevents lead sulfide from settling out in the regenerator.

Reference—Petroleum Refiner, vol 30, no 1, p 138 (Jan, 1951).



Dualayer Distillate Process—MAGNOLIA PETROLEUM COMPANY

Application—The Dualayer distillate process reduces sulfur content and improves color, odor, oxidation stability and inhibitor response of distillate fuel oils and similar products. The carbon residue, sediment and metal contents and the tendency to form cloud in storage are lowered. These improvements are obtained by removing from the oil less than one percent of the highly objectionable materials like mercaptans and oxygenated compounds. The cracked distillates treated by this process become compatible with the straight-run distillates.

Description—Fuel distillate entering the unit is mixed with concentrated caustic solution at about 130 F. The resulting emulsion passes through an electrical precipitator into a settling chamber where three layers are formed. The upper layer is the extracted oil, the middle layer contains the impurities combined with caustic and the lower layer is the unspent caustic.

The oil is withdrawn from the settler, washed with water and pumped to storage. The middle layer consisting of "salts" formed by the impurities in the oil, is withdrawn from the system. The lower layer is recirculated through the unit after a small quantity of fresh caustic solution is added to compensate for the caustic which reacted with the impurities. Traces of water produced by the chemical reactions are removed by passing a portion of the caustic solution through a small vacuum concentrator.

Operating Conditions—Typical operating conditions for the unit are shown in the following table.

Oil Rate, B/D	1,500
Temperature Inlet Oil, F.	130
Caustic Treat	
Dosage, volume percent of oil	5
Mixer Pressure Drop, psi	25
Solution Strength, wt. % of NaOH	43
Water Wash	
Dosage, volume percent of oil	10
Mixer Pressure Drop, psi	20
Concentrator	
Charge Rate, bpd	185
Temperature, F.	190
Pressure, in Hg. Abs.	27
Inlet Solution, wt. % NaOH	42
Outlet Solution, wt. % NaOH	43

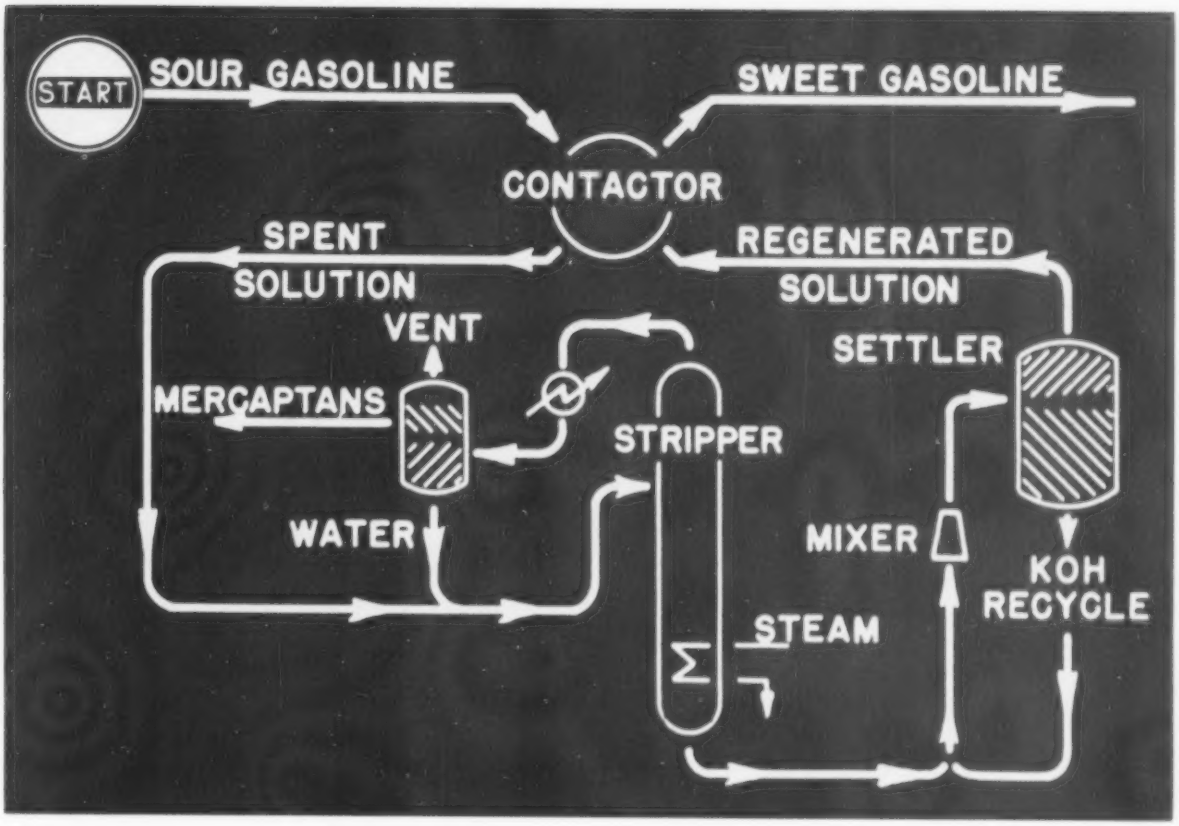
Yields—Charge and products properties of a typical treated cracked fuel oil distillate are shown in the following table.

Properties	Untreated	Treated
Gravity, °API	28.3	28.3
Color, ASTM	1½	1½
Mercaptan Sulfur, wt. %	0.022	0.001
Carbon Residue (1), wt. %	0.10	0.07
Carbon Residue (1), Blending Value (2), wt. %	0.27	0.07
After One Year Storage Equivalent (3)		
Carbon Residue (1), wt. %	0.49	0.21
Color, ASTM	8	4
Sediment, mgs./100 ml.	17.3	2.5

(1) On 10% bottoms.
(2) Blended with 25 percent by volume of sweetened West Texas straight-run kerosine of 0.04 CCR on 10% bottoms.
(3) Based on Gulf Coast temperatures. Equivalent to two years storage on East Coast.

Commercial Installations—Two 15,000-barrel units at the Beaumont refinery of Magnolia Petroleum Company in Beaumont, Texas, and two 10,000 barrel units at Eastern States Refinery, Houston.

Reference—Petroleum Refiner, vol 34, no 9, p 141 (Sept, 1955).



Dualayer Gasoline Process—MAGNOLIA PETROLEUM COMPANY

Application—The Dualayer gasoline process removes mercaptans and other objectionable acidic compounds from butane, gasoline, naphtha, jet fuels and similar petroleum distillates. The sulfur content of these distillates is reduced and the extracted products have a high stability, good odor and an excellent response to tetraethyl lead.

Description—The gasoline entering the unit is washed with a dilute caustic solution to remove hydrogen sulfide and other easily extractable substances. The gasoline is then contacted in two or three stages with 3 percent by volume or less of the Dualayer solution, washed with a small quantity of water and pumped to storage. The Dualayer solution is a strong solution of sodium or potassium hydroxide, depending on the nature of the stock treated, and contains a solubilizing agent.

The spent Dualayer solution is regenerated for reuse by diluting it with an equal part of water, reconcentrating it in a stripper where mercaptans and excess water are distilled off, and adding makeup caustic solution. A small portion of entrained gasoline released on diluting the solution with water is returned to the unit for reprocessing. Condensed water from the stripper is used for diluting the spent solution from the extractor.

No disulfides are formed in the product by oxidation of mercaptans. Treating losses are less than one percent because only the undesirable petroleum constituents are eliminated. A very small quantity of treating solution is needed to obtain the desired results. Refining costs are exceptionally low. The process is automatic and requires minimum supervision.

The name Dualayer is derived from the words dual layer and refers to the formation of two alkaline layers in the equilibrating vessel.

Operating Conditions—Typical operating conditions for the unit are shown in the following table.

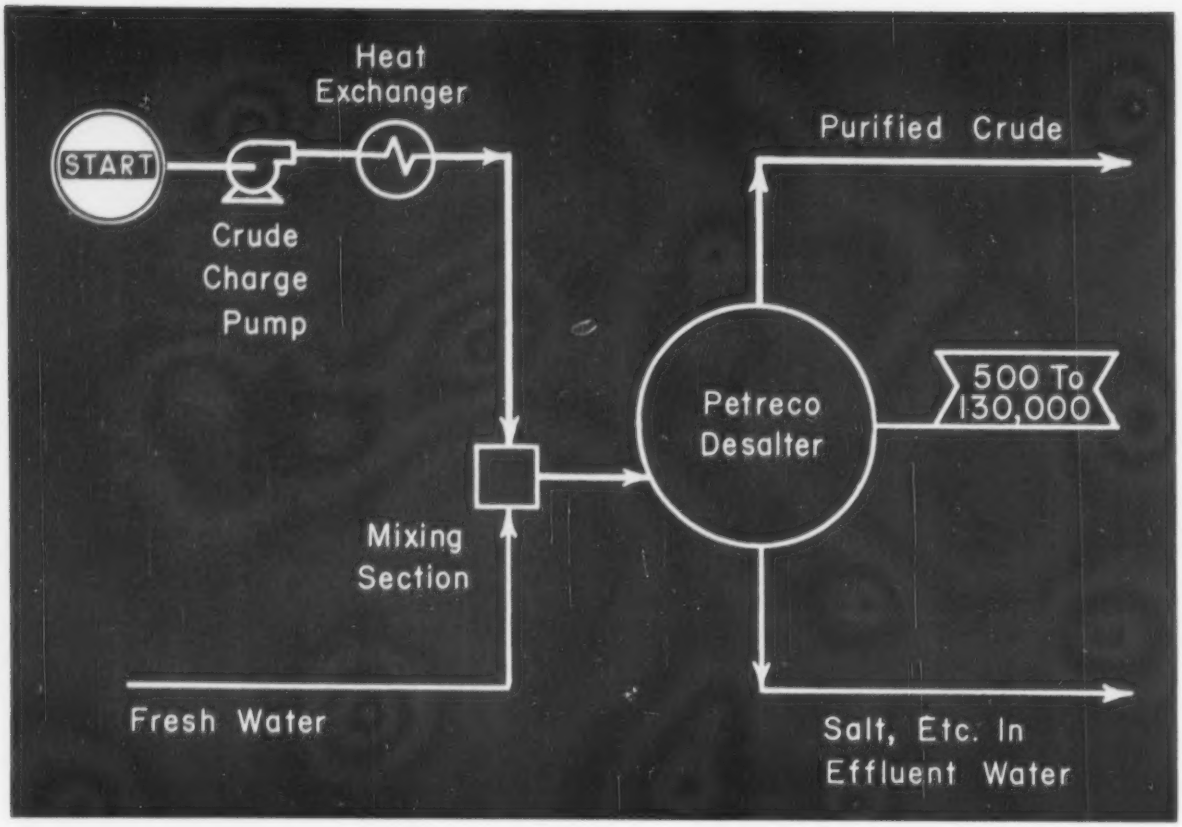
Oil Rate, bpd	15,000
Extractor Temperature, F.	120
Dualayer Solution	
Rate, bpd	450
Dosage, Vol. Percent of Oil	3
Mixer Pressure Drop, psi	10
Dilution Water Rate, bpd	350
Stripper	
Top Temperature, F.	235
Bottom Temperature, F.	322
Pressure, psig	5

Yields—Charge and product properties are shown in the following table.

	Charge	Product
Gravity, °API	71.2	71.0
Mercaptan Sulfur, Wt. %	0.091	0.001
Octane, R + 3 cc TEL	83.4	87.1
ASTM Distillation, F.		
IBP	98	97
10%	130	128
50	164	165
90	230	232
EP	320	323
Recovery, %	98	98
RVP	11.6	11.5
Color, ASTM	30	30
Sulfur, Wt. %	0.16	0.07

Commercial Application—Two 15,000-barrel units were installed and are successfully operated by Magnolia Petroleum Company at the Beaumont refinery, Beaumont, Texas.

Reference—Petroleum Refiner, vol 33, no 4, p 161 (Apr, 1954).



Electric Desalting—PETRECO DIVISION, PETROLITE CORPORATION

Application—Pre-refining purification of crude oils used as refinery charging stock. Removes salts, sediment and other impurities by means of electric precipitation.

Charge—Any crude oil used as a refinery charging stock.

Product—A purified crude charge in which salts such as chlorides, sulfates, and bicarbonates, and solids such as sand, silt and rust particles are reduced to such a degree that refinery operations are unhampered. Arsenic also is substantially reduced.

Description—In the refinery, the Petreco Desalter is an integral unit in the flow plan. It operates at relatively low temperatures (180 to 240 F.) and usually is installed at the beginning of the refining procedure, after the primary heat exchangers. Space requirements are nominal, depending on the type of Petreco unit installed, varying approximately from 150 to 1500 square feet. No utilities other than those normally available in the refinery are required. The flow diagram illustrates the simplicity of the Petreco desalter flow system.

In operation, charging crude from refinery storage is pumped into the Petreco unit after first passing through a primary heat source. After heating, the crude is mixed, under controlled conditions, with a small quantity of fresh water to form a water-in-oil emulsion. The emulsion then is dispersed into a high potential electrostatic field in the treating section. The powerful coalescing forces of the electrostatic field cause the impurities (salts, soilds, etc.) to be intimately associated with the fresh water. As this association is accomplished, the water, now serving as a carrier for the impurities, is separated rapidly from the oil and withdrawn. The purified crude oil continues on in normal refinery flow.

The three vessel types available are designated as Cylectric, Electrosphere and Vertelectric. Cylectric desalters are cylindrical, set in a horizontal position. They usually are 10 or 12 feet in diameter, the length varying according to treating capacity desired. Cylectric units are ideal for throughputs in the 10,000 to 100,000 barrel per day range, and are especially suitable where high operating pressures are desirable.

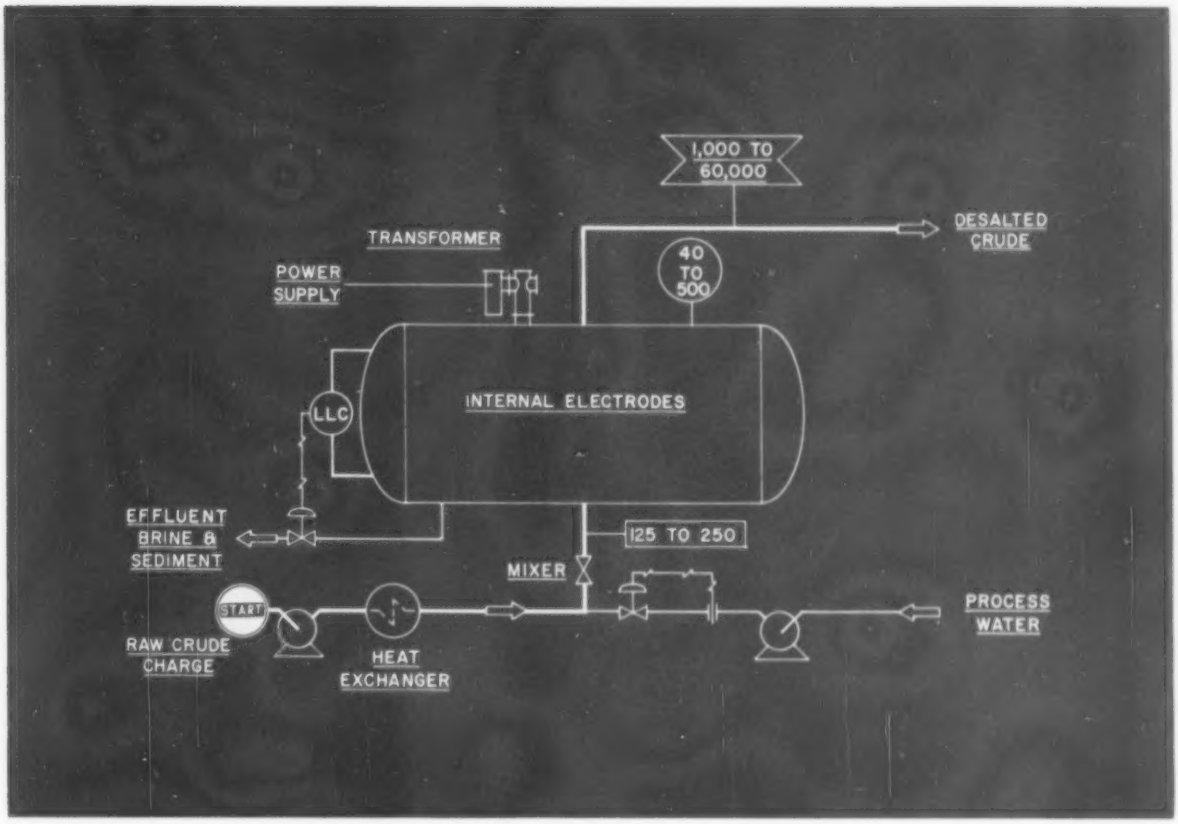
Electrospheres range in diameter from 10 to 36 feet. They have high throughput capacities, yet occupy minimum ground space. Individual Electrospheres currently are desalting up to 125,000 bpd.

Vertelectric desalters are cylindrical, set in vertical position. They are 10 feet in diameter, by about 15 feet over-all in height, with a volumetric capacity of approximately 180 barrels. Treating capacities vary from 2000 to 5000 bpd. Vertelectric desalters are designed to handle the desalting requirements of small refineries.

Operating Conditions—Operating temperatures are in the 180-240 F. range. Operating pressures vary according to the type of unit used, and are in the 50 to 300 psi range. The oil-water level, rate of flow, rate of disposal and power supply are automatically regulated by pre-set controls.

Commercial Installations—Over 310 Petreco desalting units are in operation in North and South America and the Middle East.

Reference—PETROLEUM REFINER, vol 32, no 9, p 125 (Sept, 1953).



Electrical Desalting—HOWE-BAKER CORPORATION

Application—Howe-Baker desalters are installed in the refinery raw crude charge line to remove salts and other impurities.

Charge—Crude oil.

Description—Fresh water is added to the raw crude at the rate of 4 to 8 volume percent of the oil rate to dissolve and absorb impurities. This water is mixed under controlled conditions with the crude to form a stable emulsion. The water-in-oil emulsion thus formed is resolved by introducing it into a high voltage electrostatic field inside the vessel. The action of this field is to agglomerate the dispersed water phase and force it to accumulate in the lower portion of the drum. The water which contains the various impurities removed from the crude is continuously discharged to the effluent system.

Clean desalted crude flows from the top of the vessel to the refinery flow circuit.

Provision is made for injecting small quantities of demulsifying chemical. Although not continuously required for all types of crudes, it provides flexibility so that tank bottoms, slop oils and oils with abnormally high suspended solids can be processed with maximum efficiency.

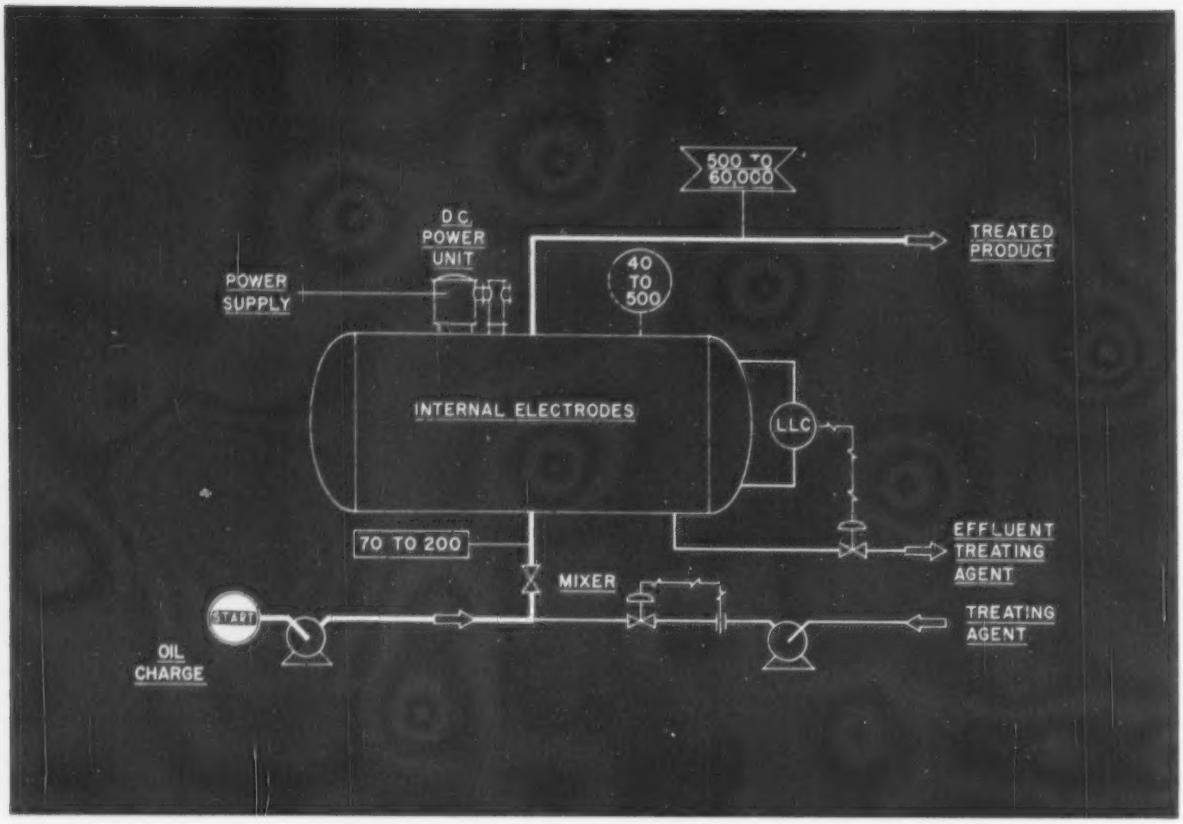
Salts in oil are most generally contained in residual water in the crude oil. Chemical composition of these salts varies widely with the major portion being sodium chlorides and lesser amounts of calcium and magnesium chlorides. All crude oils also contain as mechanical suspensions certain solid materials such as silt, iron oxides, silica or quartz sand crystalline salt, carbon and sulfur. Since many of these suspended impurities will be carried in or on water globules, a great proportion of them will be removed during the desalting process.

Advantages of electrical desalting include:

- Low operating costs
- Consistent operation under abnormal feedstock conditions
- High capacity
- Low residual salt levels.

Operating Conditions—Depending on the characteristics of the crude being treated, temperatures required at the desalters will be in a range of 125 to 250 F. A minimum operating pressure of 40 psi is required. Higher operating pressures do not affect the process and the upper limits may be established by design requirements of other elements in the flow circuits. Several plants have been installed for operating in a range of 325 to 350 psi. Savings in installation costs may be realized by using higher pressure designs in order to eliminate surge vessels and booster pumps after the desalter.

Commercial Installations—Howe-Baker desalters now in commercial use have a design capacity of over 2 million bpsd. A partial list is as follows: The Atlantic Refining Company, 50,000; California Oil Company, 30,000; Esso Standard Oil Company, 235,000; Humble Oil & Refining Company, 280,000; Imperial Oil Company, Ltd., 65,000; The Pure Oil Company, 104,000; Petroleos Mexicanos, 90,000; Shell Oil Company, 52,000; Socony Mobil Oil Company, 66,000; Sinclair Refining Company, 315,000; Standard Oil Company (Indiana), 60,000; Standard Oil Company (Texas), 25,000; Sun Oil Company, 63,000; and other foreign plants, 254,000.



Electrical Distillate Treating—HOWE-BAKER CORPORATION

Application—Treating of most distillates, from naphtha to lube oil boiling ranges, with treating agents such as caustic, acid or water.

Charge—Petroleum distillates.

Description—Electrical precipitations is a new means of implementing existing treating techniques with extremely high efficiency. A high voltage direct current electrical field is used to continuously break emulsions formed by treating agent and hydrocarbon. This makes possible higher mixing levels and better utilization of treating agent.

A typical example is the treatment of virgin heating oil with 15° Baumé caustic. Caustic is pumped into the heating oil stream and the two are intimately mixed. The emulsion formed goes to the treating vessel where it flows through the high voltage electrical field. The caustic is broken out of the emulsion and falls to the bottom of the vessel where it is continuously withdrawn. The treated heating oil flows out the top of the vessel directly to product storage. Sodium carryover in the oil, as NaOH, is less than 2 ppm. The oil is bright and haze-free.

Such an installation would eliminate the need for water washing, salt drying, air blowing or clay filtering steps, and would result in substantial savings. This is but one example of the infinite variety of feedstock and treating agents which can be handled.

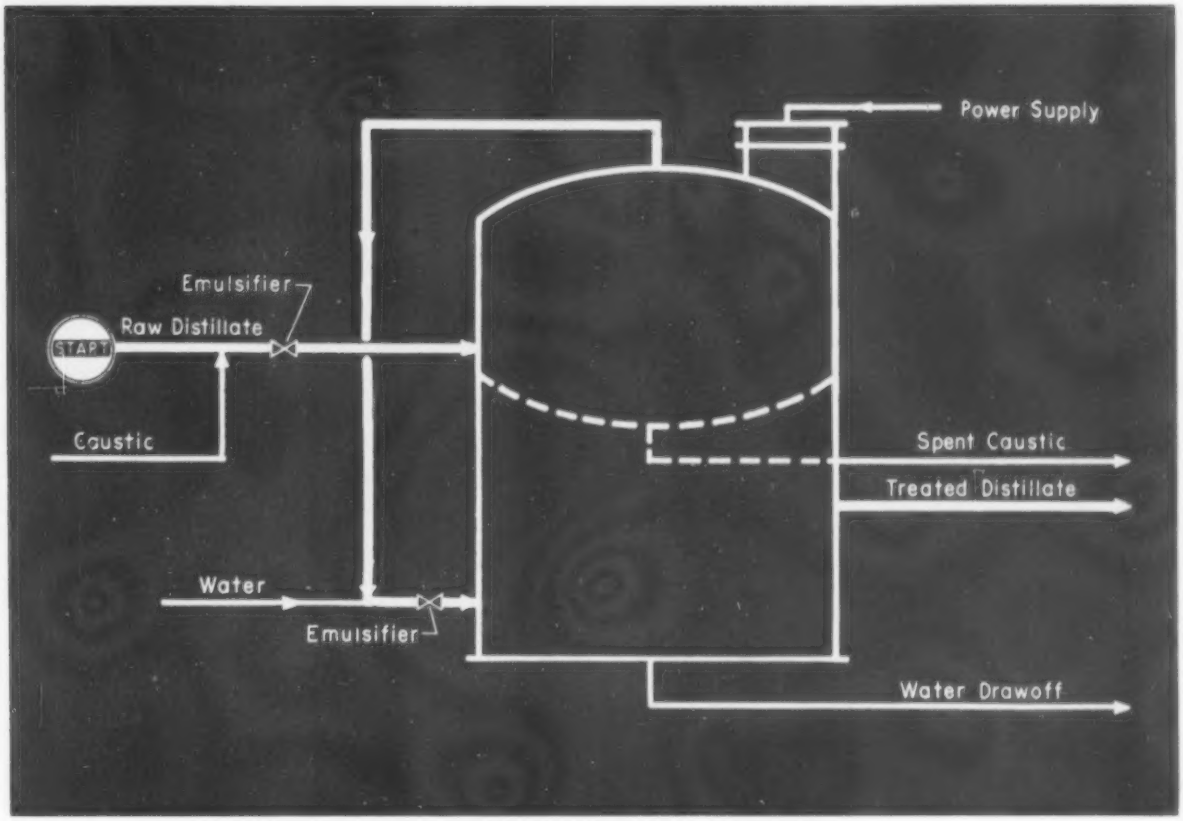
Typical treating results are shown in the table at right.

Operating Conditions—Flexibility is such that operating conditions may be varied over a wide range. Temperature normally falls in the range of 80-150 F. Very viscous stocks, such as lubes, may require higher temperatures. Operating pressure is normally in the range of 30-300 psig. Lower limit is set by vapor pressure of feedstock, and there is no upper limit except for economy of vessel cost.

Commercial Installations—Units in operation or under construction have a design capacity of 200,000 barrels per day. A partial list of purchasers of these units follows: The Atlantic Refining Company, Cities Service Refining Corporation, Esso Standard Oil Company, Humble Oil & Refining Company, Mobil Oil Francaise, Socony-Vacuum Oil Company, Standard Oil Company (Indiana), and Shell Oil Company.

Reference—Petroleum Refiner, vol 34, no 9, p 194 (Sept. 1955).

Feed Stock	Treated with	Carryover
Catalytic Heater Oil	4% of 25 Be' NaOH	2.6 ppm sodium as NaOH
Catalytic Heater Oil	4% of 50 Be' NaOH	9.7 ppm sodium as NaOH
	10% Water	0.0 ppm sodium as NaOH haze-free
Virgin Heater Oil	2% of 10 Be' NaOH	1.2 ppm sodium as NaOH
	10% Water	0.0 ppm sodium, haze-free
Kerosine (Paraffinic)	10% of 15 Be' NaOH	0.6 ppm sodium as NaOH
	10% Water	0.0 sodium, haze-free
Kerosine (Naphthenic)	10% of 15 Be' NaOH	0.4 ppm sodium as NaOH
	10% of Water	0.0 sodium, haze-free
Light Naphtha	7% of 15 Be' NaOH	0.3 ppm sodium as NaOH
Gasoline, Straight Run	7% KOH	0.47 ppm KOH
Gasoline, Cat. and Virgin Mixture	10% of 50 Be' NaOH	7.8 ppm sodium as NaOH
Gasoline, Cat. and Virgin Mixture	10% of 30 Be' NaOH	2.9 ppm sodium as NaOH
Lube Oils:		
50 ssu @ 100 F	20 vclume % H_2SO_4	0.15 volume % sludge
100 ssu @ 100 F	10 volume % H_2SO_4	0.2 volume % sludge
450 ssu @ 100 F	7 volume % H_2SO_4	0.2 volume % sludge
750 ssu @ 100 F	12 volume % H_2SO_4	6.3 volume % sludge



Electrofining—PETRECO DIVISION, PETROLITE CORPORATION

Application—Electrofining is applicable for contacting a light hydrocarbon stream with a treating agent (acid, caustic, doctor, etc.) then separating the chemical phase from the treated hydrocarbon product.

Charge—Light hydrocarbons such as gasoline, kerosine, diesel fuel, jet fuel, furnace oils, transformer oils and lube distillates.

Product—Treated light hydrocarbons, free from carry-over, stable, ready for blending or shipping.

Description—Treating chemical such as acid, caustic or doctor solution is dispersed into the hydrocarbon stream to be treated. The volume of chemical dispersed, the degree of dispersion desired, and the time and intensity of contact are all automatically controlled. The chemical-hydrocarbon mixture is then subjected to the action of the electrostatic field. The electric field coalesces the dispersed phase; the acid sludge, spent caustic or doctor solution then separates from the continuous phase.

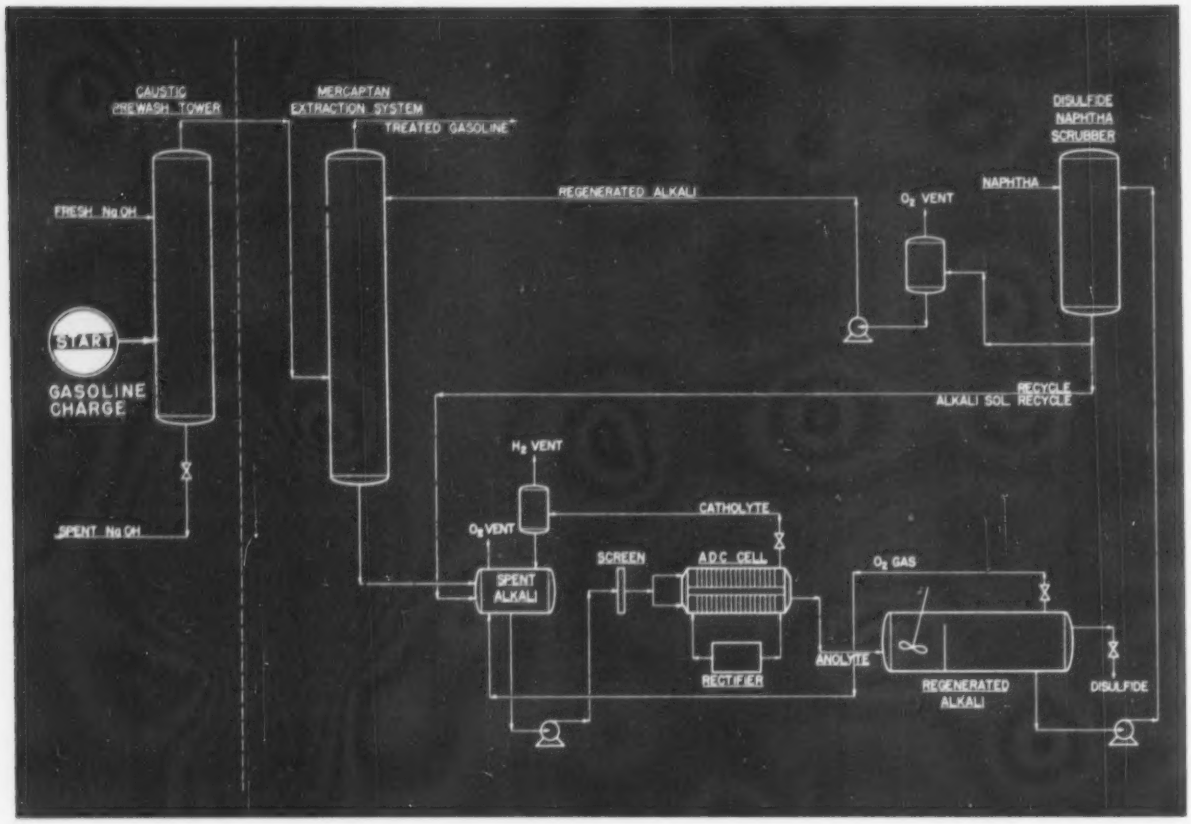
The process is extremely flexible, with options of single-stage or two-stage treaters available. Various concentrations of caustic can be efficiently applied and separated. Acid treating, or acid-acid sludge treating in series can be effected. Doctor treating, three phase treating, sulfonation and water washing are other possible alternatives. The flow diagram illustrates one of the many broad applications possible.

Operating Conditions—Electrofining operates at the normal temperatures at which the hydrocarbon to be treated flows to the run down tanks or storage. A pressure of 25 psi, or more, is required to hold the hydrocarbons in a liquid phase. A power consumption of about 1 kw is normal at the usual power voltage of 460 volts, 60 cycles.

Yield—The product quality varies with the hydrocarbon processed and the treating agent. However, in plants currently operating, it can be stated that the products are usually characterized as doctor sweet, stable in color, low in metal ions and RSH, free from carry-over and capable of passing the usual specification tests.

Commercial Installations—Forty-one Electrofining units are in daily commercial use or under construction.

Reference—PETROLEUM REFINER, vol 34, no 9, p 184 (Sept, 1955).



Electrolytic Mercaptan—AMERICAN DEVELOPMENT CORPORATION

Application—The process reduces the mercaptan content of hydrocarbon streams to improve odor and lead susceptibility.

Charge—Any hydrocarbon mixture in which the mercaptan content is objectionable.

Description—The stock is given a preliminary caustic wash if it contains, in addition to mercaptans, other acidic substances such as H_2S and acid oils. The pretreated gasoline is then contacted in a continuous countercurrent extraction system with an aqueous alkaline solution. The mercaptan-rich alkaline solution flows into the spent alkali surge drum where it is mixed with a part of the regenerated solution and oxygen gas, and then pumped through a fine screen to the electrolytic cell.

The main stream of the spent alkali flows through the anode compartments and a slip stream through the cathode compartments of the cell. In the anode compartments part of the electric current converts dissolved mercaptans to disulfides and the remainder generates gaseous oxygen. The gaseous oxygen leaves the cell along with the anolyte and is then immediately mixed in a turbo-mixer or similar device to convert additional mercaptans to disulfides. The dispersed mixture of alkali and oxygen is permitted to settle. Three phases form—gaseous oxygen, disulfides and regenerated caustic.

The unabsorbed oxygen is contacted with the contents of the spent alkali drum before venting to achieve some mercaptan oxidation prior to the entry of the solution into the electrolytic cell. The disulfides being substantially insoluble in the alkaline solution form an upper layer in regenerated alkali settler and are periodically drawn off.

The regenerated caustic leaving the settler is given a naphtha or butane wash to remove disulfides. Part of the regenerated solution leaving the naphtha scrubber is recycled to the spent alkaline tank; the remainder is pumped to the extraction system for further service.

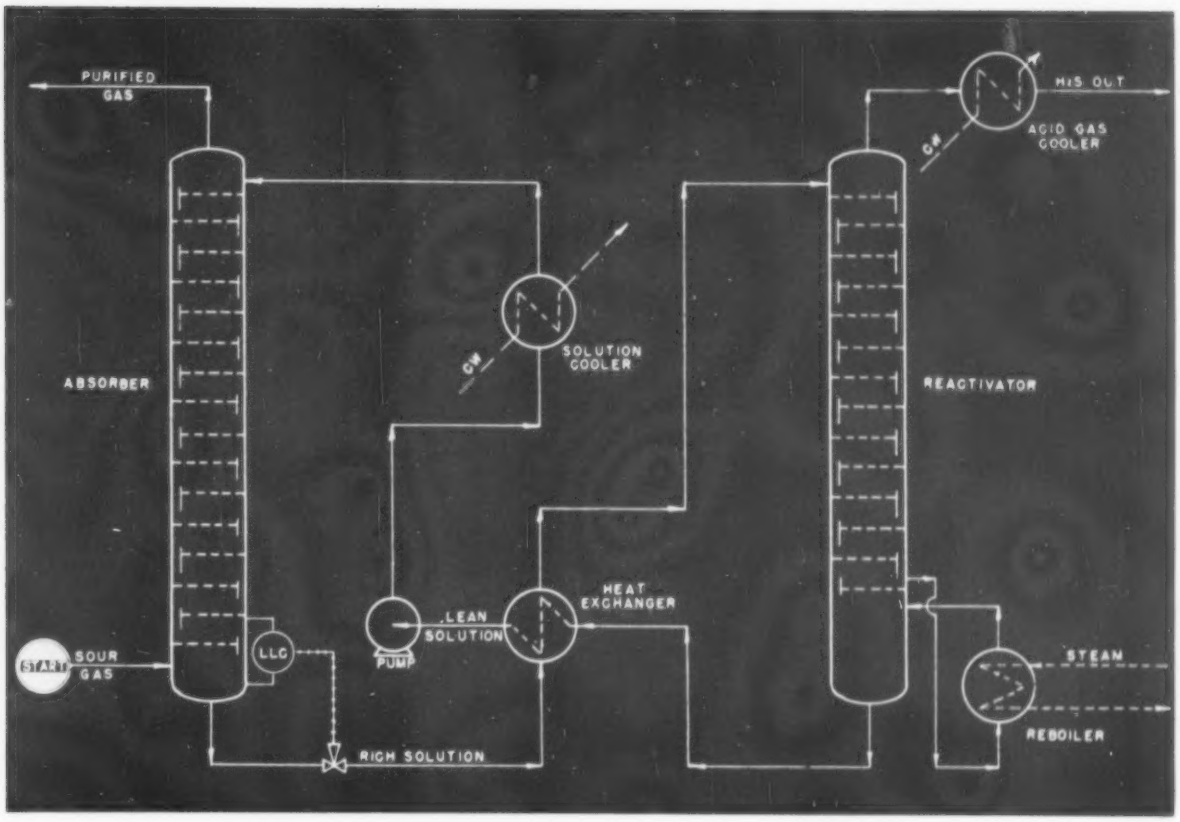
The hydrogen formed in the cathode compartments of the cell is vented, the catholyte being recycled to the spent alkali drum.

The ADC electrolytic cell is of the filter press type with permeable diaphragms between adjoining plates, and the rectifier is of a conventional type. Otherwise, the process employs ordinary refinery equipment. Corrosion is at a minimum since the process normally operates at ambient temperatures and neither heating nor cooling is necessary.

The extractant may be any aqueous solution capable of extracting mercaptans from hydrocarbons and possessing reasonable conductivity. NaOH or KOH solutions are generally used. With adequate pretreatment, no chemicals are consumed in the regenerative cycle.

Commercial Installations—The first unit was installed at Ashland, Ky., during 1951. Capacity—5000 barrels per day. Additional units have been installed at Raffineries Francaises de Petrol de L'Atlantique, Donges, France—6500 barrels per day; Leonard Refineries, Alma, Mich.—5000 barrels per day; Sun Oil Company, Carnia, Ontario—2000 barrels per day; Arabian American Oil Company, Ras Tanura, Saudi Arabia—25,000 barrels per day.

Reference—PETROLEUM REFINER, vol 33, no 11, p 205 (Nov, 1954).



Girbotol—THE GIRDLER COMPANY

Application—The process is employed for removal and recovery of hydrogen sulfide from natural and refinery gases, for desulfurization and dehydration of natural gas, for purification of liquid hydrocarbons, and for separation of carbon dioxide from hydrogen and synthesis gases.

Description—The Girbotol process originated with the discovery that acidic gases such as hydrogen sulfide and carbon dioxide react with certain amines to form compounds which may be broken down by heat. This reversible reaction may, in the case of hydrogen sulfide, be represented as follows:

$$RNH_2 + H_2S = RNH_3HS \text{ (where R represents an organic radical)}$$

The equilibrium proceeds to the right or left, depending on the temperature, and on the partial pressure of the hydrogen sulfide. The solutions generally employed are aqueous solutions of ethanolamines, mono-(MEA), di-(DEA) or tri-(TEA).

The operation is a continuous process in which the solution passes through the absorber where hydrogen sulfide is removed from the gas, through a heat exchanger and into the reactivator. In the reactivator hydrogen sulfide is stripped from the rich solution by heat and passes out of the tower as a concentrated gas together with some steam into the acid gas cooler. The steam is condensed in this cooler and returned to the cycle while the hydrogen sulfide may be flared, burned under a boiler or recovered as elemental sulfur.

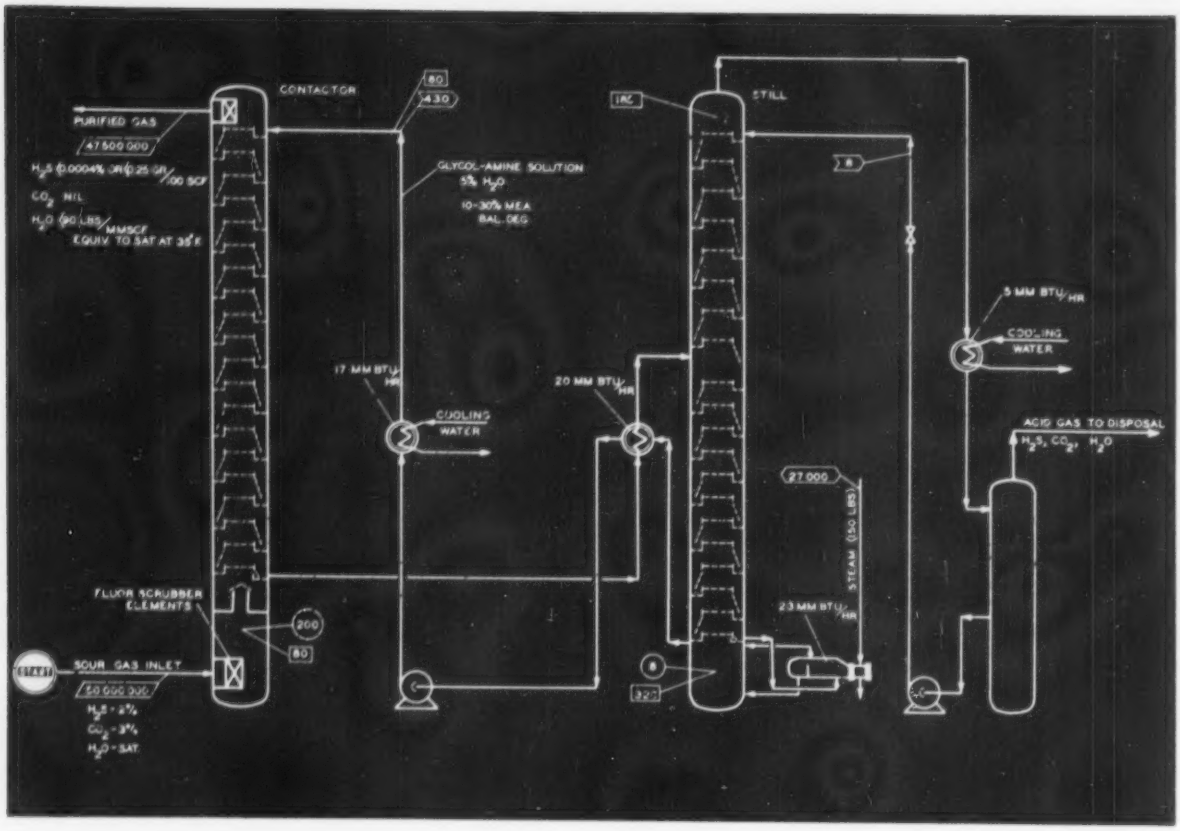
The lean solution, essentially free from acid gases, passes from the bottom of the reactivator through the other side of the heat exchanger, a circulating pump, a solution cooler and back to the absorber. The case shown is typical for high pressure natural as operation. The absorber and reactivator towers may be either packed or bubble plate towers of conventional design.

Another type of Girbotol process is in use for purifying liquid hydrocarbons in a similar manner. A packed or sieve plate tower is used for the absorber and either the liquid hydrocarbon or the Girbotol solution maintained in a continuous phase depending on the specific case.

Operating Conditions—The choice of the proper amine and solution strength depends on the composition of the gas to be treated, the percentage of hydrogen sulfide and/or carbon dioxide in the gas and the final purity desired. In many cases it is possible to attain a moderate degree of selectivity by the proper choice of solutions and operating conditions where complete hydrogen sulfide removal is desired and carbon dioxide removal is not required. The solution circulation rate of a Girbotol plant depends on the above factors as well as on the quantity, temperature and pressure of the gas to be treated. If the gas mixture is at its hydrocarbon dewpoint, the treating temperature should be maintained 10 to 20 F. above the inlet gas temperature to prevent the condensation of hydrocarbons in the treating equipment. Girbotol plants are customarily designed to purify gases at their full line pressure and the pressure drop through the equipment ordinarily will not exceed 5 to 10 psi.

Commercial Installations—Several hundred.

Reference—*Petroleum Engineer*, vol 26, no 10, p C-57 (Sept, 1954).



Glycol-Amine Gas Treating—THE FLUOR CORPORATION LTD.

Application—The process is applied for the continuous removal of hydrogen sulfide, carbon dioxide, and water vapor from gas streams. By the use of methyldiethanolamine, this process may be adapted to remove water and hydrogen sulfide from gas streams with selective removal of CO_2.

Product—Sour natural gas may be treated so that the residue gas will contain a guaranteed maximum of 0.15 grain of H_2S per 100 scf and be dehydrated to a degree equal to that obtainable with a straight glycol dehydrator.

Description—The process utilizes a mixture of amine (commonly monoethanolamine) and glycol (di- or triethylene glycol) in a simple regenerative cycle. As shown in the flow diagram which represents a typical application, the sour gas is introduced into the bottom of the absorbing column, the contractor. As it passes upward through the bubble trays it is thoroughly contacted with the glycol-amine solution, which enters at the top of the vessel. The outlet gas, free of the CO_2 and H_2S and dehydrated, leaves the top of this column. The rich solution containing the absorbed acid gases leaves the bottom of the contactor and passes through a bank of conventional heat exchangers, wherein the temperature of the solution is raised. The rich solution then enters the regenerating column, the still. As it flows down over the bubble trays in this column it is contacted with the rising stripping vapors, thus stripping the solution of the acidic constituents. The solution from the bottom tray of the still enters a reboiler, wherein it is boiled to provide the stripping vapor for the column. The overhead stream of acid gas and water vapor from the still passes through a condenser, and the resultant mixture is separated in an accumulator, the acid gases passing overhead from this vessel and the condensate being returned to the still as reflux. The regenerated lean glycolamine solution leaves the bottom of the still, passes through the exchangers, and is pumped back through coolers to the top of the contactor, thus completing the cycle.

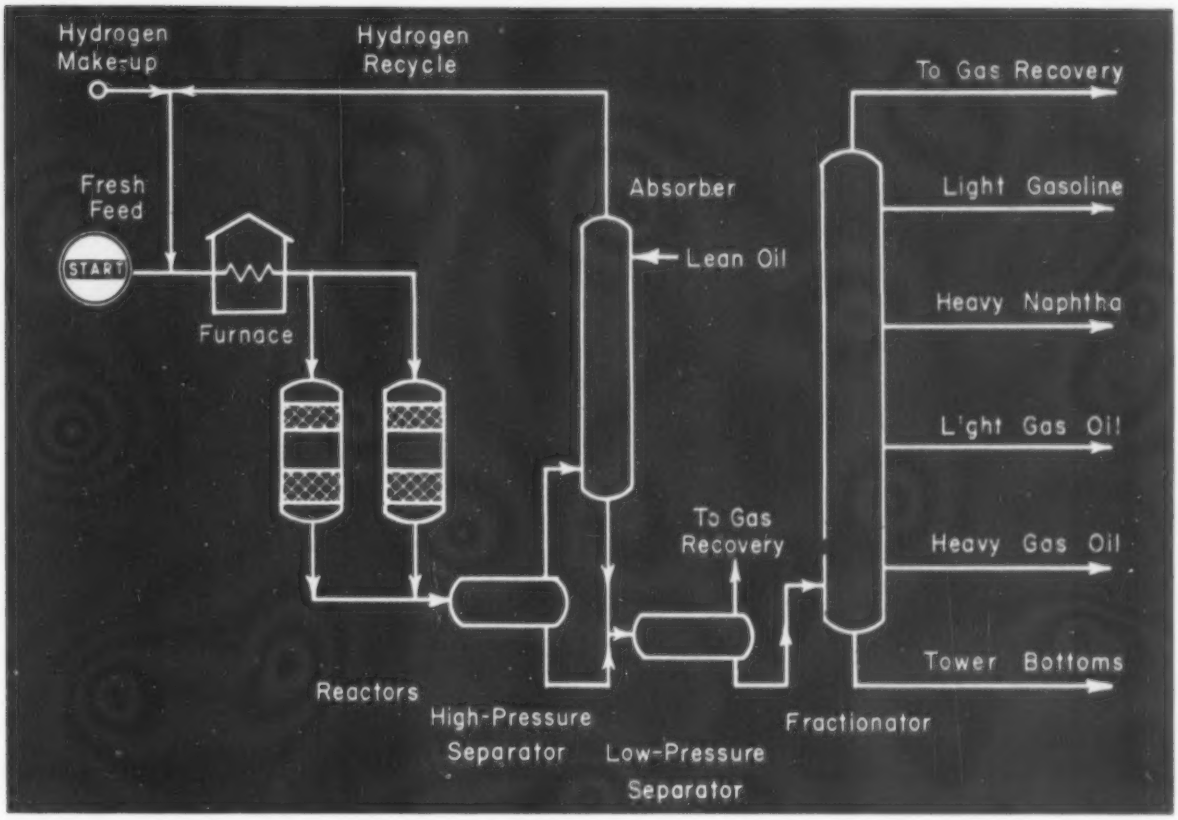
Typical solutions employed in the process may be comprised from 10 to 30 percent monoethanolamine, 45 to 85 percent diethylene glycol, and 5 to 25 percent water. The ability to adjust components of the glycol-amine-water solution makes possible a wide range of specifications for treated gas purity and water content.

Although the primary advantage of such a process over the use of aqueous amine solutions for treating is the fact that dehydration is also obtained, other important advantages have resulted in the use of this process for cases where dehydration is not a prime requisite. These advantages include the ability to produce extremely high purity gas, a lower initial investment, decreased consumption of steam, and more satisfactory operation with regard to such factors as foaming and corrosion.

Yields—As a typical example, one installation in which approximately 60 Mmscf per day of gas containing 450 grains H_2S per 100 scf was treated yielded a purity of less than 0.05 grain per 100 scf.

Commercial Installations—The total installed capacity of glycol-amine plants at this time is in excess of one and one-quarter billion standard cubic feet per day.

Reference—Petroleum Refiner, vol 32, no 9, p 124 (Sept, 1953).



Gulf HDS—GULF OIL CORPORATION

Application—The Gulf HDS Process upgrades the quality of high sulfur sour crudes and residual stocks by hydrogenation at moderate pressure.

Charge—High sulfur crude oils and residual stocks.

Product—Low sulfur stocks.

Description—Fresh feed to the unit, together with hydrogen make-up recycle gas is heated to the desired reaction temperature in a furnace and the combined streams enter the reactor which is "on stream." The reactor effluent, after being cooled in exchangers, enters the high-pressure flash drum where the rich gas is flashed off as feed to the absorber tower. Condensate from the high-pressure drum goes to the low-pressure drum where it is combined with the rich oil from the absorber tower. Condensate from the low-pressure drum is fed to the fractionator tower for separation of the desired products. During the processing periods part of the sulfur and some coke are deposited so that periodic regeneration is required. Much of the sulfur, which was converted to H_2S during the reaction period, goes along with the lighter gas and is eventually stripped out in the recovery system.

Regeneration of the catalyst is accomplished by preheating either a live steam- or flue gas-air mixture to a temperature of about 750 F. in a radiant furnace and then passing it through the reactor to be regenerated. The rate of regeneration is controlled by keeping a constant reactor inlet temperature and air-to-steam ratio.

Operating Conditions—Normal range of operating conditions vary with the feed stock and the degree of desulfurization desired, as given below.

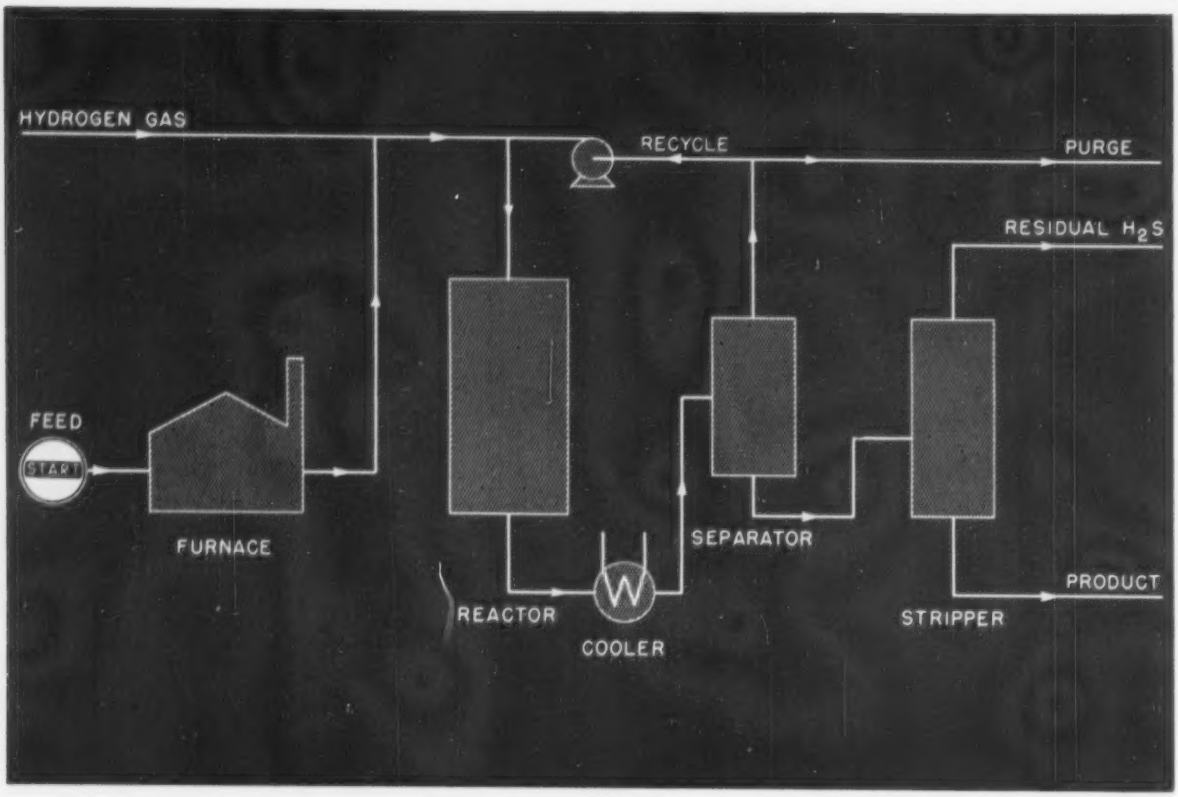
Reactor Temperature	F	750-850
Reactor Pressure	PSIG	500-1000
H_2 Conc. of Recycle Gas	Vol. %	65-90
Space Velocity	V/Hr/V	0.5-2.0
Recycle Gas Rate	SCF/bbl.	2500-5000

Commercial Installations—There are no commercial units to-date. The M. W. Kellogg Company is the licensing agent.

References—The Oil and Gas Journal, vol 54, no 2, p 196 (May 16, 1955).

	Kuwait Whole Crude		Kuwait 17% Reduced Crude	
	Charge	Product	Charge	Product
Total Charge & Product:				
Yield, Volume Percent	...	96.0	...	101.8
Desulfurization, Percent	...	82.5	...	69.9
Gravity, °API	30.8	42.4	5.8	20.8
Sulfur, Percent	2.61	0.46	5.45	1.64
Carbon Residue, Percent	5.3	0.06	19.8	8.43
Fractionation of Charge & Product:				
C_4 and Lighter, Vol. Percent	2.4	3.2	...	0.5
Debutanized 300° F E.P. Gasoline				
Yield, Volume Percent	16.4	25.8	...	6.5
Gravity, °API	70.3	68.9	...	62.8
Sulfur, Percent	0.04	0.03	...	0.17
Motor Octane, Clear	47.2	53.9	...	54.0
Naphtha, 300-410° F				
Yield, Volume Percent	9.2	14.9	...	5.2
Gravity, °API	50.5	47.8	...	43.9
Sulfur, Percent	0.16	0.05	...	0.11
Motor Octane, Clear	23.4	39.8	...	46.4
Furnace Oil, 410-670 F				
Yield, Volume Percent	22.6	35.7	...	19.3
Gravity, °API	37.3	34.3	...	30.8
Sulfur, Percent	1.21	0.47	...	0.54
Cetane No.	...	...	...	45
Bottoms, 670° F. & Heavier				*
Yield, Volume Percent	49.4	20.4	...	21.1
Gravity, °API	14.4	20.9	...	21.3
Sulfur, Percent	4.11	0.84	...	0.93
Carbon Residue, Percent	9.8	0.88	...	0.21
Bottoms 925 F. & Heavier				
Yield, Volume Percent				47.4
Gravity, °API				9.6
Sulfur, Percent				2.40
Carbon Residue, Percent				19.4
Hydrogen Consumption SCF/Bbl. Charge	...	499	...	650
HDS Yields—Wt. Percent of Charge				
Dry Gas	...	4.7	...	1.5
Depropanized Liquid Product	...	89.8	...	92.3
Catalyst Carbon	...	3.3	...	2.4
Sulfur Removal	...	2.2	...	3.8

Note * Kuwait Reduced Crude—670-925 F. Fraction.



Hydrofining—ESSO RESEARCH AND ENGINEERING COMPANY

Application—Hydrofining is a versatile hydrogenation process which may be used for sulfur removal and general upgrading of products.

Charge—Gas oils, heating oils, kerosines, solvents, cracked naphthas, virgin naphthas, lube stocks and waxes.

Product—Product quality, for the variety of stocks which can be treated, will vary with the degree of treatment used in this flexible process. In treating fuels—a popular application of the process—Hydrofining will successfully lower sulfur content, reduce odor, prevent formation of gummy deposits and carbon residues, and generally correct those properties which might tend to foul engines and oil burners. Product yield is 100 percent on the oil feed.

Description—The oil feed enters a coil furnace, where it is heated to a temperature, usually between 550 and 800 F. It then passes to a fixed bed reactor vessel together with the fresh hydrogen gas. In the reactor, the feed is treated in the presence of the hydrogen and a regenerable metal oxide catalyst at pressures usually between 50 to 800 psi. After leaving the reactor, the product is cooled before entering a separator from which hydrogen-rich gas is recirculated back to the reactor in amounts varying according to the specific requirements of the finishing operation. After separation, the product stream enters a stripper where any residual hydrogen sulfide gas is removed.

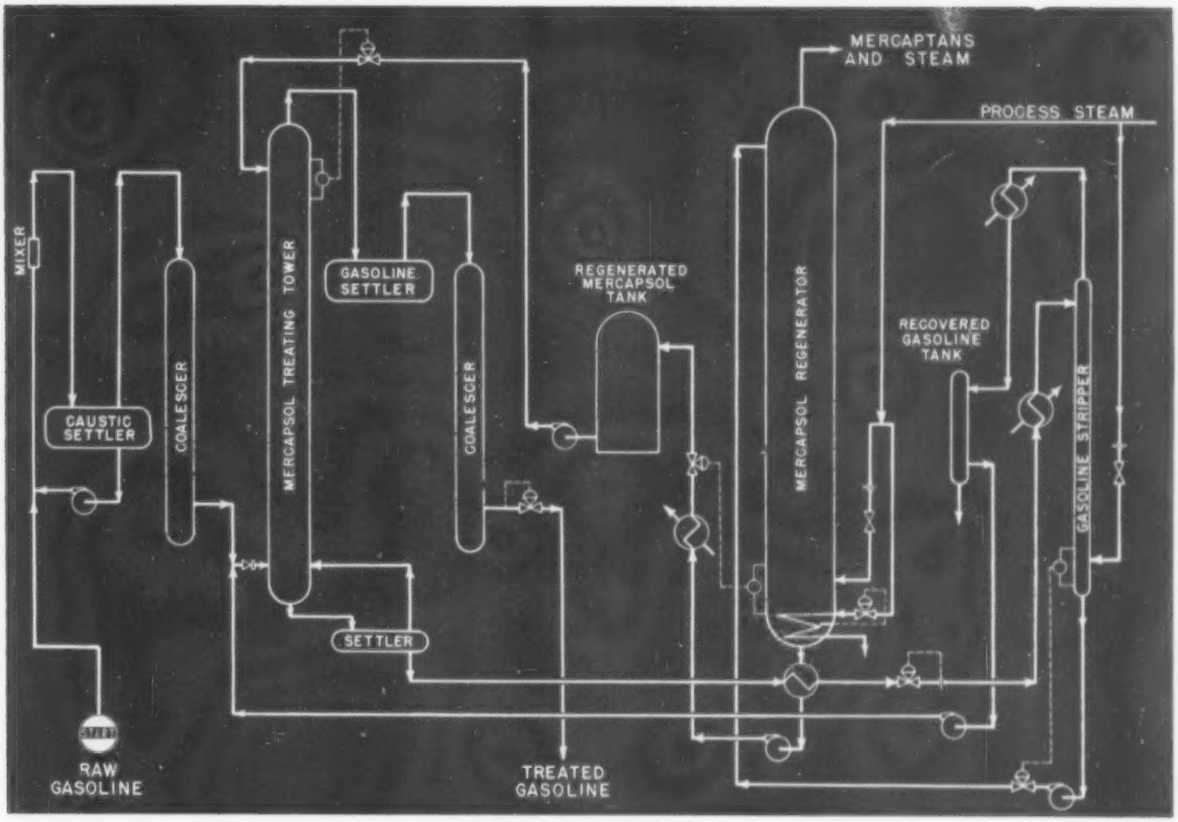
Commercial Installations—See table.

Reference—PETROLEUM REFINER, vol 34, no 9, p 220 (Sept, 1955).

HYDROFINING UNITS[1]
(Operating, Building, or Approved)

COMPANY	Location	Capacity B/SD	Feed Stock	Status
Esso Std. Oil Co.	Baltimore, Md.	12,000	Cracked Naphtha	Operating
Esso Std. Oil Co.	Baltimore, Md.	5,000	Cracked Heating Oil	Operating
Esso Std. Oil Co.	Baton Rouge, La.	3,000	Solvent Naphtha	Design
Esso Std. Oil Co.	Bayonne, N.J.	2,500	Wax	Operating
Esso Std. Oil Co.	Linden, N.J.	7,000	Cracked Naphtha	Operating
Esso Std. Oil Co.	Linden, N.J.	19,500	Cracked Heating Oil	Operating
Esso Std. Oil Co.,	Linden, N.J.	15,000	Light Naphtha	Design
Carter Oil Co.	Billings, Mont.	6,000	Diesel Fuel	Operating
Humble Oil & Refg. Co.	Baytown, Texas	38,000	Heating Oil (2 units)	Operating
Humble Oil & Refg. Co.	Baytown, Texas	8,800	Lubes	Operating
Humble Oil & Refg. Co.	Baytown, Texas	15,000	Cracked Naphtha	Operating
Imperial Oil, Ltd.	Sarnia, Ont.	600	Lubes	Operating
Imperial Oil, Ltd.	Sarnia, Ont.	400	Wax	Design
Imperial Oil, Ltd.	Edmonton, Alberta	2,000	Lubes	Operating
Creole Pet. Corp.	Amuay, Venezuela	17,000	Diesel Fuel	Design
Creole Pet. Corp.	Amuay, Venezuela	700	Lubes	Design
Esso Std. Oil, S.A.	Belot, Cuba	2,400	Diesel, Kerosine,	Design
Esso Std. Ref. Scc. An.	Antwerp, Belgium	4,400	Gas Oil	Design
Esso Petroleum, Ltd.	Fawley, Eng.	3,700	Tractor Fuel	Operating
Esso Petroleum, Ltd.	Fawley, Eng.	1,600	Solvents	Operating
Esso Petroleum, Ltd.	Fawley, Eng.	12,200	Diesel Fuel	Design
Esso Petroleum, Ltd.	Fawley, Eng.	12,200	Diesel Fuel	Approved
Esso A.G.	Hamburg, Germany	8,400	Diesel Fuel	Operating
Esso A.G.	Cologne, Germany	12,200	Gas Oil	Design
Esso A.G.	Cologne, Germany	2,500	Jet Fuel	Design
STANIC	Leghorn, Italy	9,500	Diesel Fuel	Approved
Esso Std. Soc. An. Fr	Port Jerome, France	13,600	Gas Oil	Design
Arabian American Oil Co.[2]	Ras Tanura, S. Arabia	15,000	Diesel Fuel	Design
Jones & Laughlin Steel Co.[2]		700	Benzol	Design
Leonard Refineries[2]	Alma, Mich.	3,800	Heavy Gas Oil	Operating
Leonard Refineries[2]	Alma, Mich.	8,200	Light Gas Oil	Operating
Total		265,000		

[1] Does not include Hydrofining units to prepare feed stocks for catalytic reforming units; capacity of such units is more than 190,000 barrels per day.
[2] Licensee unit.



Mercapsol—THE PURE OIL COMPANY

Application—The Mercapsol treating process removes mercaptan sulfur compounds from gasoline thereby providing a method for meeting sulfur and odor specifications and for improving the lead susceptibility.

Charge—Mercapsol treating is especially attractive for use on straight run, thermally cracked or thermally reformed gasolines which are frequently very difficult to treat by other methods.

Product—In most cases a reduction in mercaptan sulfur content of 95 to 99 percent can be accomplished conveniently, and many gasolines can be extracted to doctor sweetness directly. In almost any case the use of a suitable gum inhibitor after Mercapsol treating will result in a doctor sweet product. Since mercaptans are actually removed from the gasoline instead of being converted to disulfides or other sulfur compounds, the product contains less total sulfur than the charge, and the process thus aids very materially in meeting sulfur specifications. One of the principal advantages of the process is an improvement in the tetraethyl lead susceptibility of the gasoline. An improved gum inhibitor susceptibility is an additional benefit.

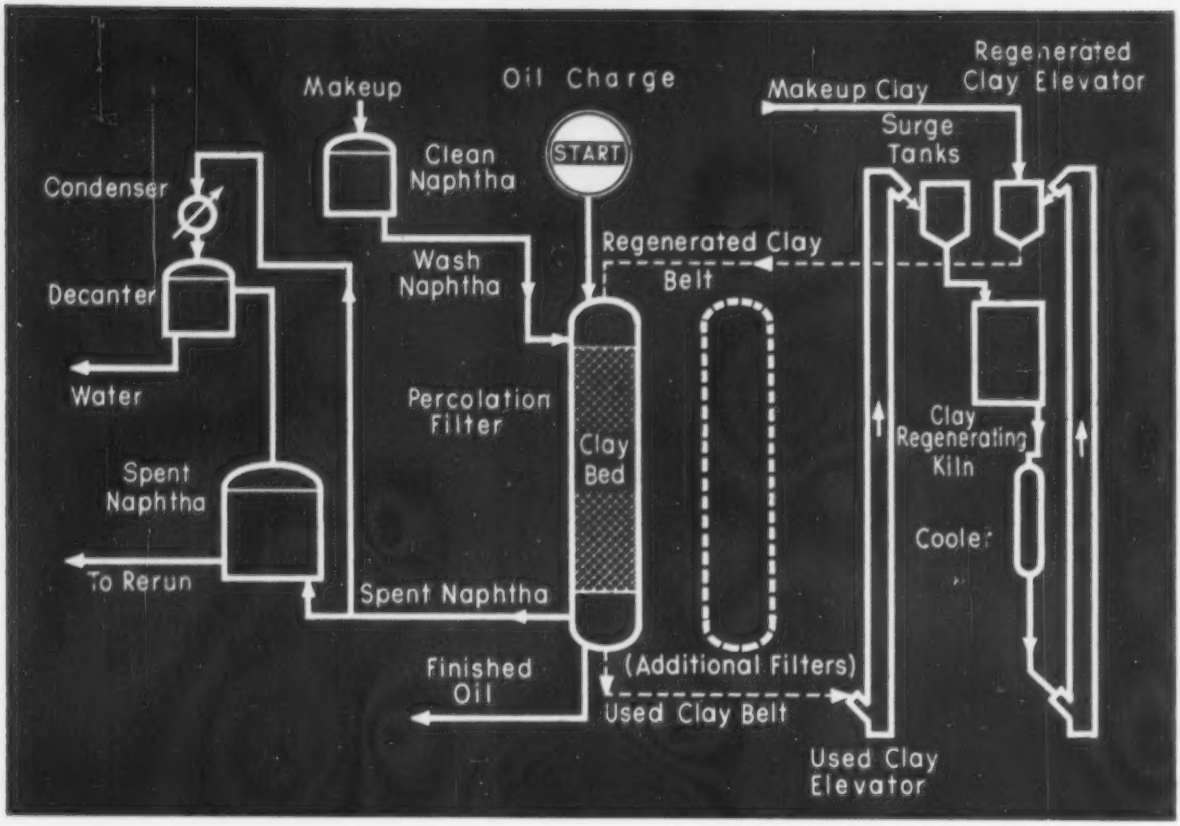
Description—The operation of the process is illustrated by the flow diagram. Gasoline is treated in the liquid phase at ambient temperatures. Hydrogen sulfide and other acidic substances, which would otherwise build up in the permanent treating solution, are first removed by contact with low strength caustic solution. The gasoline from this step passes through a coalescer whose function is to remove any aqueous phase which would contain sodium sulfide and other salts. The gasoline then enters the treating tower near the bottom, where it is intimately contacted counter-currently by the descending continuous phase of Mercapsol solution which effectively extracts the mercaptans. From the top of the treating tower the treated gasoline flows through a settler and a coalescer for clarification and on to inhibiting and storage.

Spent Mercapsol solution containing the extracted mercaptans is withdrawn from the bottom of the treating tower into a settler from which the gasoline that separates can return by density difference to the tower. The treating solution as it then flows from the Mercapsol settler contains a small amount of dissolved gasoline which is recovered and returned to the treating tower. Recovery of the dissolved gasoline is accomplished in a small stripper by the use of a small amount of steam which is sufficient for this purpose but not enough to strip much of the mercaptan present. The Mercapsol is then steam stripped of mercaptans in the regenerating tower, and after cooling is stored in the regenerated Mercapsol tank from which it is pumped to the top of the treating tower to repeat the cycle.

The Mercapsol treating solution is an aqueous solution of sodium hydroxide containing salts of certain acid oils which act as solubility promoters for mercaptans. With proper precautions against contamination and loss the solution may be used indefinitely.

Commercial Installations—Mercapsol treating is currently being used in two plants of The Pure Oil Company.

Reference—*The Oil and Gas Journal*, vol 42, no 49, p 126 (Apr 13, 1944).



Percolation Filtration—MINERAL & CHEMICALS CORPORATION OF AMERICA

Application—The process is applied for finish refining of lube oils and other fractions.

Product—Finished oils and waxes are characterized by excellent color, odor and taste, and by their stability in demulsifying properties.

Description—The process consists of filtering the oil or other charge through a vessel commonly containing 10 to 50 tons of adsorbent media, either fuller's earth or activated bauxite. After a preliminary period during which the clay bed is thoroughly soaked with charge oil, the latter is passed through the clay until the adsorbent fails to produce specification products. The first oil out is lightest in color. The color of the effluent oil darkens gradually as more and more oil flows through the unit. After the oil stream has stopped, naphtha is sent through the clay bed to reclaim the remaining oil. Steaming follows to recover the naphtha. The clay is then conveyed to a kettle for burning off the carbonaceous deposits of oil and impurities and returned to the filter for another cycle. The 20/60 and 30/60 mesh adsorbent grades have been found to be best adapted to most percolation refining operations.

The choice between activated bauxite and fuller's earth as the preferred percolation adsorbent is predicated on comparative costs and product quality considerations. In many cases the same high product quality is possible with either adsorbent and the choice may rest solely on any difference in capital investment or on operating costs.

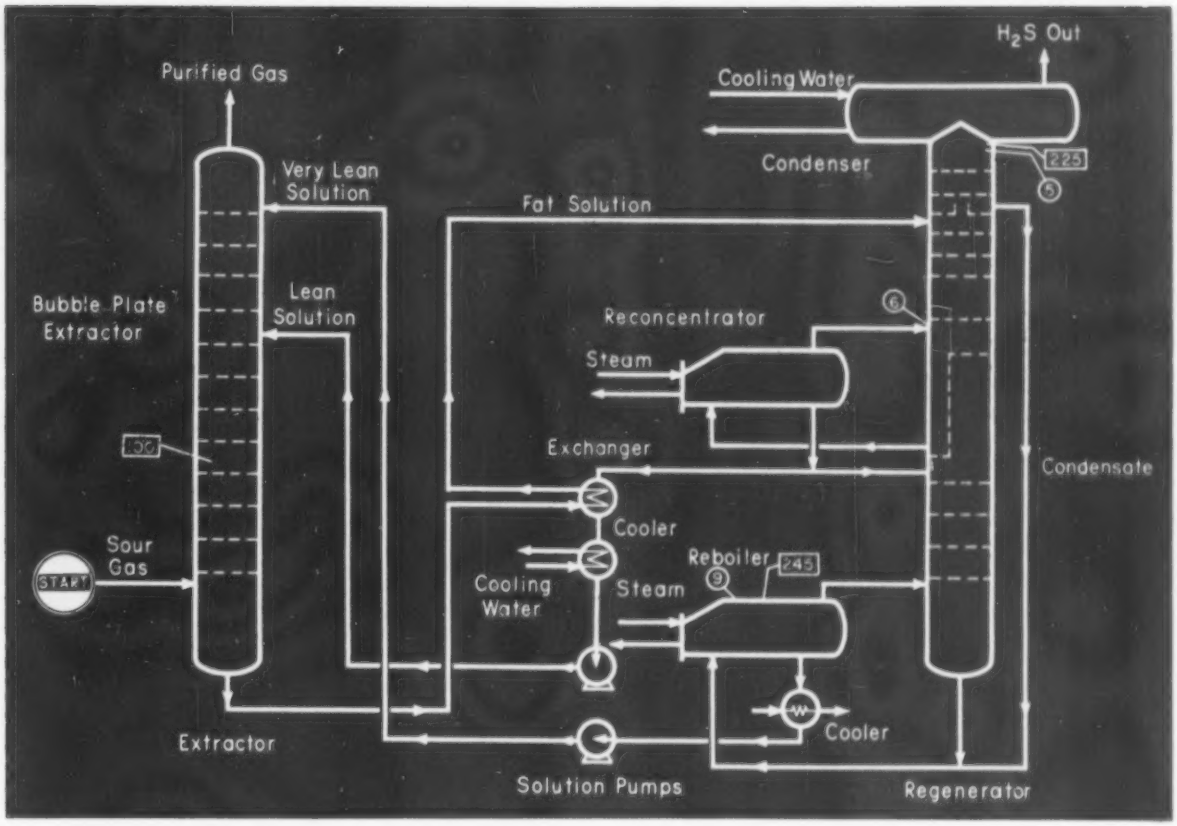
Yields—See table. The relative yields will vary with different oils, the principal factors influencing them being crude oil source and the amount of refining pre-treatment lubricating oil fractions received prior to filter finishing. Generally heavy decolorization requirement will favor fuller's earth while lighter color loads (less color reduction) will favor bauxite.

Commercial Installations—More than 53 installations.

References—*Petroleum Processing*, vol 2, no 9, p 673 (Sept, 1947).

CRUDE SOURCE	PROCESSING (A)	(B)	(C)	UNFILTERED OIL INSPECTION API Gr.	Viscosity-S.U. 100° F.	210° F.	Viscosity Index	Pour Point °F.	Color NPA	PERCOLATION YIELD New Fullers Earth Bbl./Ton	Bbl./MCF	New Bauxite Bbl./Ton	Bbl./MCF	Color NPA
North Louisiana		P	MEK	28.0	207.0	46.5	92	—10	2—	77	1280	48	1360	1½
West Texas		D	MEK	32.7	208.8	47.4	103	— 5	1¾	257	4270	151	4270	1
Cal-Waxy		P	P	28.9	325.7	51.5	76	— 5	4 dil	84	1395	65	1840	2
Iraq		F	MEK	28.1	457.0	60.8	95	0	7¼	160	2650	130	3690	3
Oklahoma		F	MEK	29.1	511.6	62.6	90	0	4¾	52	865	114	3230	2
East Texas	Yes	D	MEK	27.7	1115.7	92.4	93	0	8	25	415	23	642	4
East Texas	Yes	P	MEK	27.4	1678.2	117.3	94	5	5¾	52	865	47	1330	5
West Texas	Yes	D	MEK	26.6	1618.3	119.3	99	5	7—	63	1045	60	1700	6

(A) Propane deasphalting. (B) Solvent extraction—P = Phenol, F = Furfural, D = Duosol. (C) Dewaxing—MEK = Methylethylketone—benzol, P = Propane.



Phosphate Desulfurization—SHELL DEVELOPMENT COMPANY

Application—The Shell Phosphate process is a continuous cyclic process for removing and recovering hydrogen sulfide from natural and refinery gases and liquid hydrocarbon fractions. The process consists of two steps: absorption and regeneration.

Description—The principal absorption reaction may be expressed by the equation:

$$K_3PO_4 + H_2S = K_2HPO_4 + KHS$$

Regeneration of the solution is effected by means of stripping steam, which reverses the absorption reaction.

Treatment of gas and liquid streams differs only in the design of the extractor and, generally, in the use of split-solution flow for gas treating. The sketch shows the split-solution flow scheme.

Under actual operating conditions the tripotassium phosphate solution used in the process removes H_2S preferentially from gases containing both H_2S and CO_2. This unique feature of the Phosphate Process may be highly advantageous in desulfurization of natural or synthesis gases. In such cases it is often unnecessary or undesirable to remove most of the CO_2 along with H_2S for reasons besides the higher attendant stripping steam consumption.

The Phosphate process is particularly suitable for recovery of H_2S from which it is desired to make elemental sulfur. For that purpose it is important that the recovered H_2S be of high purity, i.e., with minimum CO_2 and hydrocarbon content. The Phosphate process can remove H_2S economically from gases containing CO_2 and H_2S in ratios as high as 20 to 1.

In treating gases, the extraction step is carried out in a bubble-tray column using split-solution flow. The raw gas is contacted countercurrently with the lean solution in the lower section of the column for removal of the bulk of the H_2S; as it proceeds through the upper part of the column, the gas is further contacted with the very lean solution to achieve the final degree of H_2S removal required.

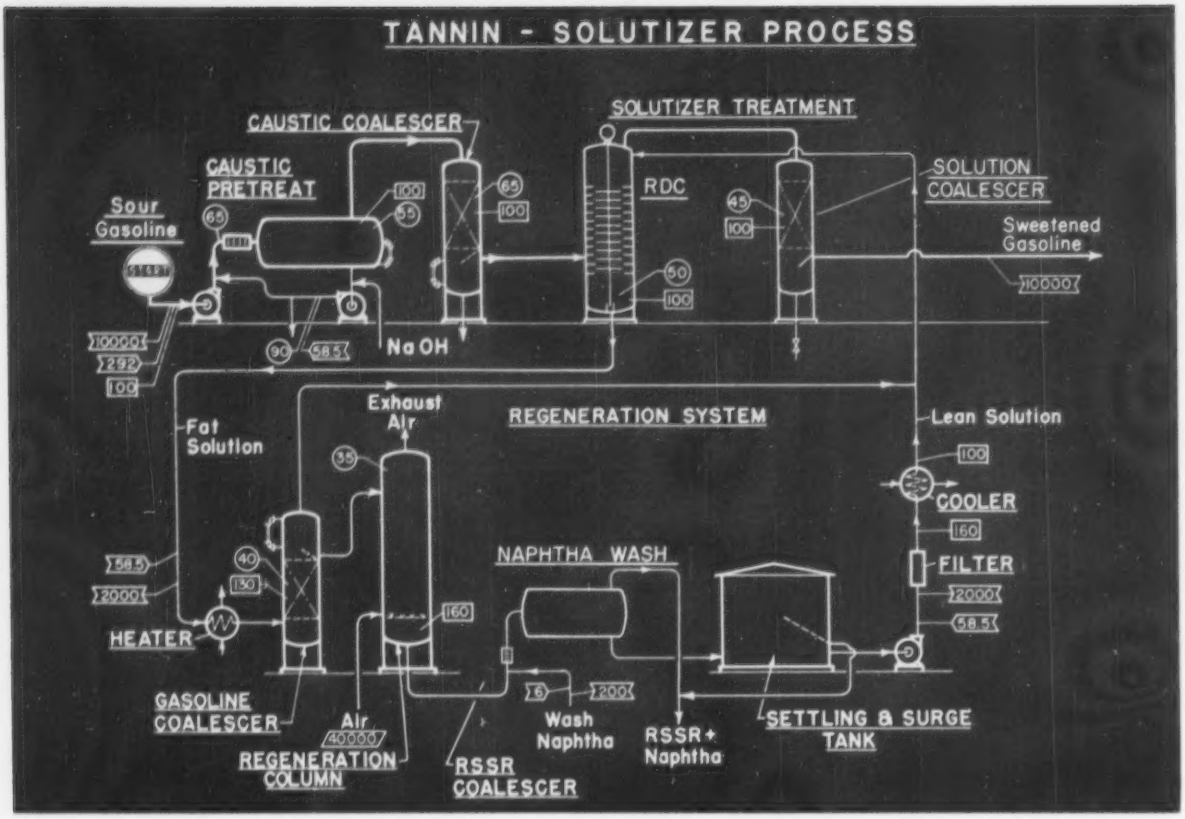
In the treatment of liquid hydrocarbon streams, the extraction step is achieved with countercurrent single-solution flow. After extraction, the liquid hydrocarbon flows through a solution coalescer which serves to safeguard against solution loss through entrainment.

The hydrogen sulfide recovered by this process is essentially free of hydrocarbons and is an ideal raw material for manufacture of sulfuric acid or elemental sulfur.

Since K_3PO_4 is a stable inorganic salt which does not decompose nor vaporize under treating conditions, it does not contaminate nor polymerize the hydrocarbons and the solution loss is negligible. Iron and steel are satisfactory for all equipment. If the cooling water is corrosive, admiralty-metal tubes and Muntz metal sheets and baffles may be used in the condenser and solution coolers. Gages, instruments, valves, and pumps should be all iron and steel. Observance of these general specifications will insure freedom from corrosion on the process side.

Commercial Installations—Forty plants have been installed.

Reference—Petroleum Refiner, vol 18, no 8, p 334 (Aug, 1939).



Solutizer Process—SHELL DEVELOPMENT COMPANY

Application—The Tannin Solutizer process is a cyclic process—removes mercaptans from sour gasolines.

Product—Mercaptan removal to the "odor sweet" level of 0.001 to 0.003 weight percent mercaptan sulfur is easily achieved when treating a wide range of straight-run or cracked stocks, either low-end-point or full-boiling-range gasolines.

Description—The three essential steps of the process are caustic pretreatment, solutizer treatment, and regeneration. Caustic pretreatment is often necessary to remove acidic components such as hydrogen sulfide and, in some cases, to control the alkyl phenol concentration. A single conventional mixer-settler arrangement is usually satisfactory for this purpose, and the caustic solution may be used until it is essentially saturated. A coalescer follows the caustic settler to minimize contamination of the potassium hydroxide treating solution with sodium ion.

For mercaptan extraction the sour hydrocarbon feed is contacted with a suitable solutizer solution in countercurrent flow. The solution may contain as solutizer either added fatty acids or naturally occurring alkyl phenols. The latter may be used if their concentration in the fraction treated is great enough to maintain the required solutizer strength in the treating solution.

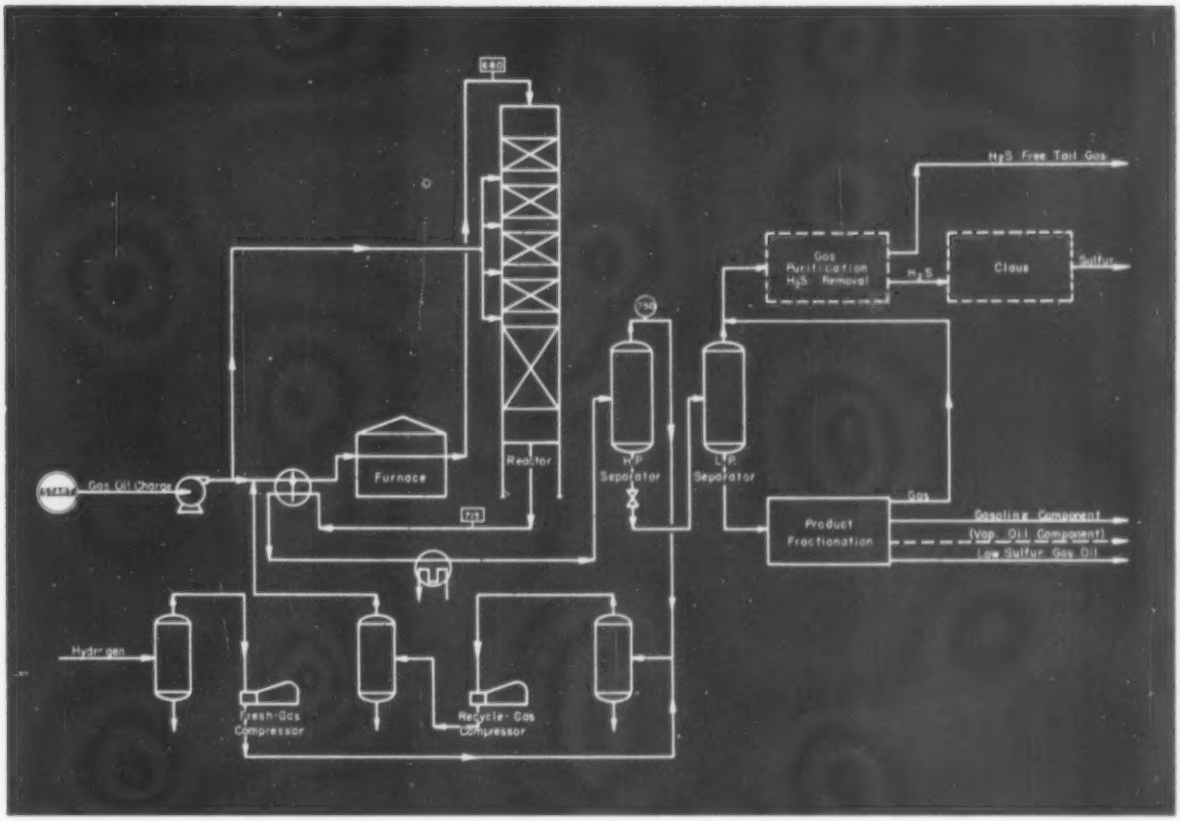
In the past, mixer-settler units have been used for the mercaptan extraction step. However, in all new designs, the Shell Rotating Disc Contactor (RDC) has replaced mixer-settlers. Use of the new apparatus in this step of the process substantially reduces capital cost and adds significantly to operating flexibility.

The treated hydrocarbon flows from the extraction section to storage or subsequent operations. The spent treating solution is heated to 130 to 160 F., passes through a gasoline coalescer, and enters the regenerator where the extracted mercaptans are oxidized to disulfides by air blowing. This operation is accomplished in a column equipped with efficient air dispersers or in any standard liquid-gas mixing device. Dissolved and/or entrained disulfide oil is removed by a naphtha wash. The naphtha required is only 1 to 2 percent of the gasoline treating rate, and it may be disposed of by adding it to reforming or catalytic cracking charge stock. The regenerated solutizer solution is then cooled and returned to the extraction step.

The extracting agent is strong potassium hydroxide solution containing mercaptan solubility promoters (solutizers) such as fatty acids; e.g., propionic and butyric acids, and/or alkyl phenols.

No corrosion-resistant metals are required as operating temperatures are low and the treating solution is non-corrosive. Labor costs are low due to simplicity of operation and adaptability to virtually complete automatic control. The solution is inexpensive and has an extended treating life, so that chemical cost is nominal. Exhaust steam can be used to fulfill the limited heating requirements.

Reference—Petroleum Refiner, vol 18, no 5, p 171 (May, 1939).



Trickle Hydrodesulfurization—SHELL DEVELOPMENT COMPANY

Application—The process is used to remove sulfur from middle distillates by means of the reaction of sulfur compounds with a minimum amount of hydrogen.

Charge—Middle distillates such as straight-run and catalytically-cracked gas oils.

Product—A sulfur removal of 85 to 90 percent is obtained, a small fraction of high-octane gasoline being produced from the sulfur compounds.

Description—As shown in the diagram, the oil charge and fresh hydrogen, as well as recycle hydrogen, are combined. The combination is first preheated by exchange with hot reaction products, and then is heated in a small gas- or oil-fired furnace.

The reactor may contain a number of catalyst beds between which cold charge oil is injected to take up the heat produced in the exothermic hydrogenation reactions. The number of beds required depends upon the sulfur and olefin content of the charge stock and upon the degree of sulfur removal desired. With low-sulfur stocks, i.e., stocks with a sulfur content of, say, approximately 1 percent by weight or less, intermediate cooling may be omitted. The reaction products, after heat exchange with the feed, are cooled further and then passed to the high-pressure separator—from which, after the addition of makeup hydrogen, the gas is recycled. The liquid from the high-pressure separator is flashed in a low-pressure separator, and is then passed to a product fractionating section for removal of the remaining hydrogen sulfide and light ends.

If desired, an engine-fuel type of kerosine component may be recovered. The low-pressure tail gas may be passed to a gas-purification plant for removal of hydrogen sulfide, which may subsequently be converted to sulfur in a Claus plant.

For most commercial applications the rate of decrease of catalyst activity will be extremely low, corresponding to a catalyst life of the order of one year.

Operating Conditions—The preferred operating conditions for deep sulfurization of middle distillates (80 to 90 percent sulfur removal) are 600 to 850 psia and 680 to 730 F.

Yields—The table below shows typical product properties for the hydrodesulfurization of a Middle East light catalytically cracked gas oil:

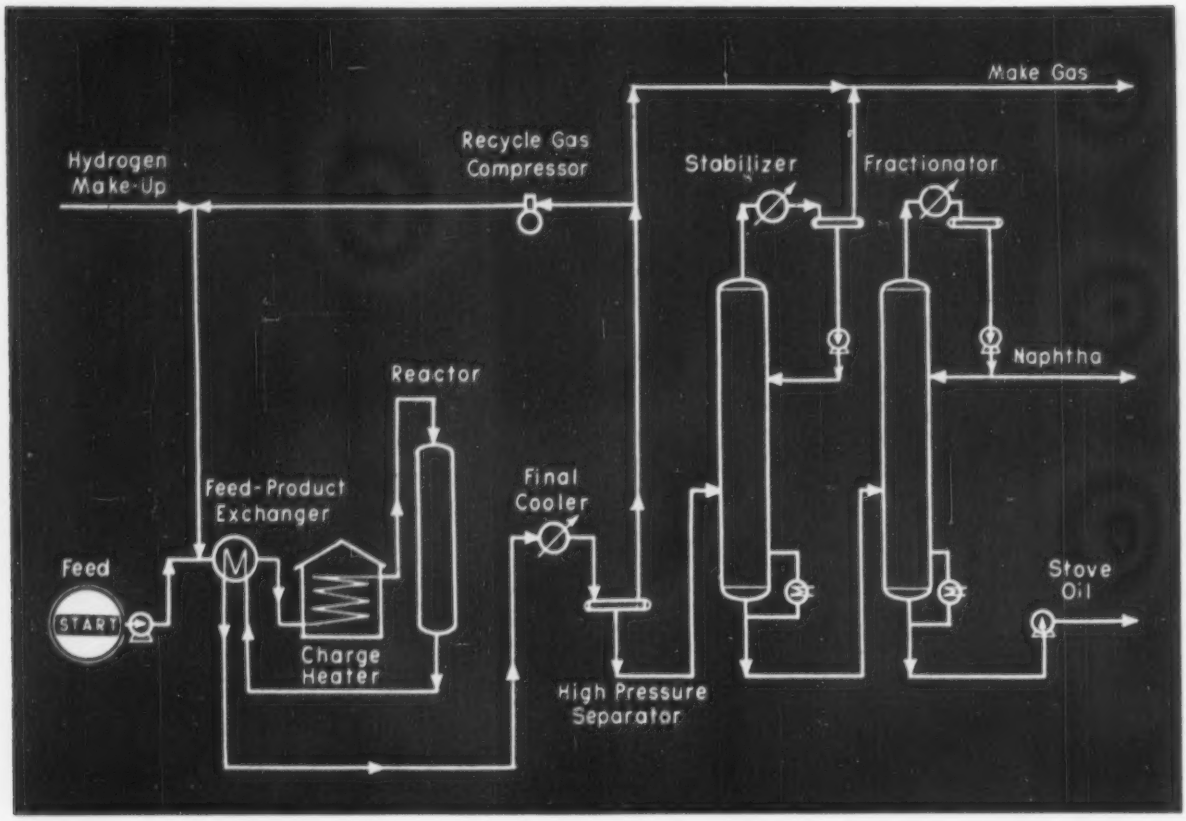
Processing Conditions:

	Cobalt-molybdenum-alumina
Catalyst	
Pressure, psia	750
Temperature, Fahrenheit	710
Liquid Hourly Space Velocity, Vol. per Vol. per Hour	3.0
Recycle-Gas Rate, scf per Barrel	1350

	Feed Stock	Product* Under 430 F	Product* 430 to 500 F	Product* 430 F Plus	Product* 500 F Plus
Percent Weight of Feed	100	9.9	20.3	87.6	67.3
Percent by Volume of Feed	100	10.7	21.3	90.4	69.1
Gravity, Deg. API	21.3	33.8	25.4	20.1	25.5
ASTM Distillation (Fahrenheit)					
Initial Boiling Point	446	270	437	475	532
End Point	650	417	480	650	650
Sulfur, Percent by Weight	2.90	0.01	0.02	0.34	0.43
Extractable with 98 Percent Sulfuric Acid, perc. by Wt.	70	87	80		
Octane Numbers:					
ASTM, Without TEL Addition		90	77		
CFR Research, Without TEL Addition		100+	88		
Pour Point, Fahrenheit	14			19	25
Diesel Index	19.5			27.1	29.9

* Sharp Fractionation.

Reference—PETROLEUM REFINER, vol 34, no 9, p 152 (Sept, 1955).



Unifining—UNION OIL COMPANY OF CALIFORNIA & UNIVERSAL OIL PRODUCTS COMPANY

Application—Unifining is a versatile catalytic hydrogenation process for removing sulfur, nitrogen, oxygen and other contaminants from petroleum fractions.

Charge—The process may be applied to either straight-run or cracked feedstocks, whether light or heavy, of high-sulfur content or low.

Products—The objectives of Unifining include: 1) Reduction in sulfur and nitrogen compounds; 2) Preparation of catalytic reforming feedstocks, whether straight-run or cracked; 3) Improvement in odor, color, gum and storage stability; and 4) Improvement in burning properties, cetane number, lead susceptibility, and susceptibility to catalytic cracking.

Description—The accompanying diagram shows an equipment arrangement for the simultaneous preparation of catalytic reformer feed and high-grade stove oil by the processing of coker distillates. The feed is combined with hydrogen recycle gas, preheated by heat exchange with reactor products, and heated to the required reactor inlet temperatures. On passing through the reactor, the desired catalytic reactions are accomplished and these may occur in either vapor-phase or mixed-phase conditions, depending on the specific application.

The reactor products, after heat exchange, are cooled and flow to a high-pressure separator. The hydrogen-rich gas is recycled back to the reactor. Any excess over process requirements is vented to fuel. The high-pressure separator liquid flows to a stabilizer for removal of dissolved light gases and is shown in this figure as a conventional refluxed stabilizer. In other specific applications the stabilizer may be replaced by a stripper, rectified absorber, or other comparable equipment. The stabilized product is then ready for fractionation as indicated in this flow diagram, or may be utilized directly.

Products and Yields

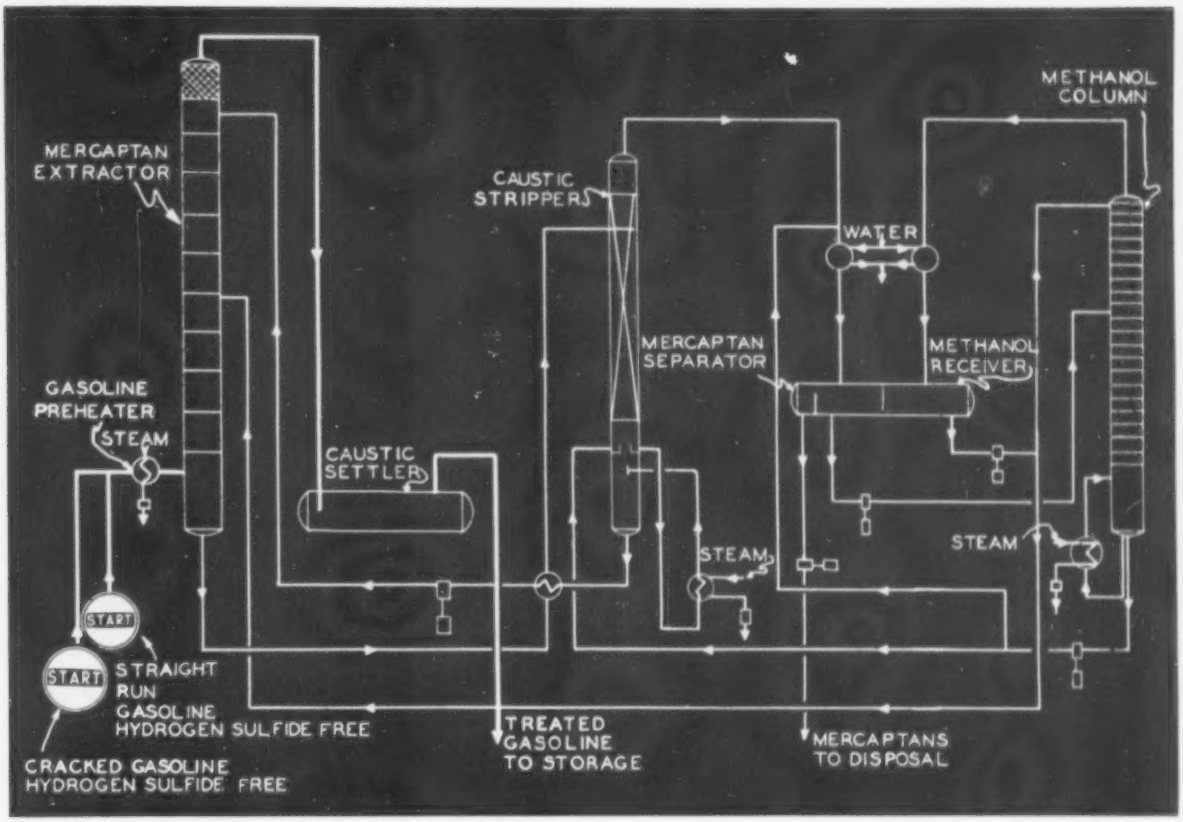
A 15,750 bpsd Unifining unit has been in full commercial operation for about two years treating a mixture of high sulfur, high nitrogen naphthas derived mainly from coking operations. The bulk of the product is reformer feedstock. Typical commercial data are:

Unifining Coker Distillates

	Total Charge (Mixed California Distillates)	PRODUCTS	
		Rerun Overhead	Rerun Bottoms
Gravity, °API	47.8	55.0	38.6
ASTM Dist., F.:			
Initial	190	152	390
10	230	212	390
50	300	270	415
90	400	340	432
Maximum	450	380	490
Sulfur, Total Weight Percent	1.90	0.005	0.01
Nitrogen, Basic, PPM	225	0.2	1.0
Bromine No.	20	Nil	Nil
Doctor Test	Sour	Sweet	Sweet
Liquid Yield, Vol. Percent of Charge		101	

Commercial Installations—The first commercial installation was made in 1953. At the present time about sixty units have been licensed for operation. These units represent the application of Unifining to straight-run, thermal, catalytic and coker naphthas; straight-run kerosine, diesels, and burner oils; vacuum and visbreaker distillates and gas oils; catalytic cycle stocks; aromatic distillates; and lube oils. A Unifining license may be obtained from either Universal Oil Products Company or Union Oil Company of California, Commercial Development Division.

Reference—PETROLEUM REFINER, vol 35, no 7, p 193 (July, 1956).



Unisol Mercaptan Extraction—UNIVERSAL OIL PRODUCTS COMPANY

Application—The process extracts mercaptan sulfur compounds and certain nitrogen compounds from gasoline and higher boiling petroleum fractions.

Product—Mercaptan reduction of better than 99 percent is readily accomplished by the process. Octane number improvements at the 3 cc tetraethyl lead level range from one to three or more points in commercial operations, depending on the mercaptan sulfur content of the untreated gasoline.

The treated product as it comes from the unit is usually sweet or nearly sweet. In almost all cases the product is completely sweet after a short time in storage, particularly if inhibited with UOP No. 5 Inhibitor, which has the unique property of accelerating air sweetening.

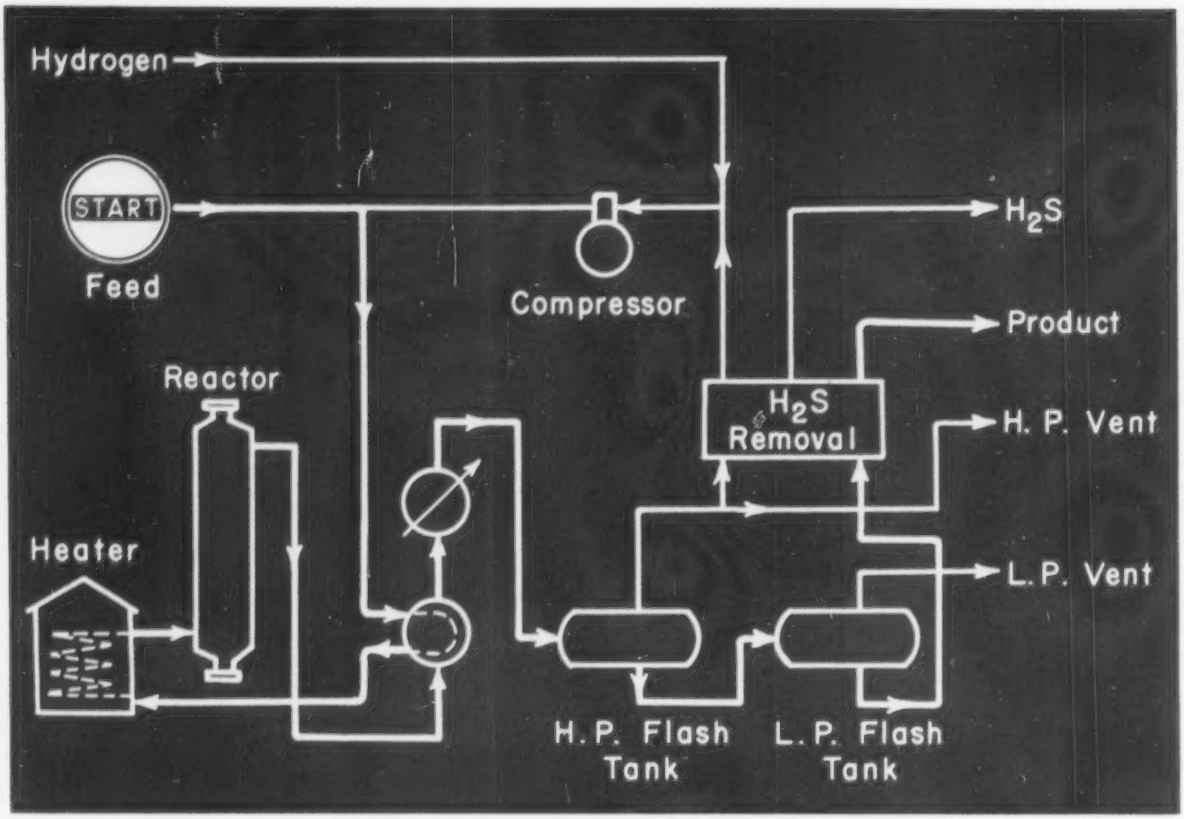
In comparisons of the properties of Unisol treated gasoline with the raw gasoline or with the product obtained by conventional sweetening, it is generally found that Unisol treating improves inhibitor susceptibility and lowers ASTM gum, and that copper-dish gums, after inhibiting, are considerably lower. Recently developed modifications enable the process to remove 95% or more of the mercaptans from distillates such as kerosine and domestic heating oil, thereby producing an oil with superior odor characteristics. Pyrrole-type nitrogen compounds are also removed by the process. Removal of sulfur and nitrogen compounds by Unisol treating markedly reduces color and sediment forming tendencies in distillate oils. Filter and burner tip plugging tendencies of domestic fuel blends of virgin and catalytically cracked cycle stocks are greatly reduced by Unisol treating.

Description—Hydrogen sulfide-free gasoline is charged to the bottom of an extraction column where it meets in countercurrent flow an aqueous solution of methanol and caustic soda. The caustic solution is introduced near the top of the extractor and the methanol enters near the mid-point. The caustic soda is introduced separately, above the methanol inlet, in order to recover any methanol dissolved in the gasoline.

Treated gasoline is recovered as an overhead product, and receives no subsequent treatment except addition of inhibitor. The mercaptan-rich caustic-methanol solution is withdrawn from the bottom of the extraction column and charged near the top of the caustic stripper. Here mercaptans, water and methanol are taken overhead, leaving the caustic solution as a bottom product ready for re-use.

The mercaptan-rich methanol is diluted with water, cooled and collected in a separator from which the mercaptans are decanted as an oily supernatant layer for disposal. The aqueous methanol solution then is transferred to a fractionator which recovers nearly anhydrous methanol as an overhead product for return to the process, and a water bottom product. The water is charged to the caustic stripper, where it evaporates to form stripping steam. No water is withdrawn from the system.

Reference—*Oil and Gas Journal*, vol 47, no 19, p 95 (Sept 9, 1948).



Vapor-Phase Hydrodesulfurization—SHELL DEVELOPMENT COMPANY

Application—This process is used to treat aviation and motor gasoline blending components to produce low-sulfur, low-gum products.

Charge—Cracked naphthas and straight-run distillates.

Products—Aviation and motor gasoline blending stocks, light distillate fuel oil, and mineral spirits.

Description—The flow pattern for the process is shown in the acompanying diagram. Raw feed is mixed with hydrogen, and the combined stream is preheated by heat exchange with reactor products and then in a furnace. From the furnace the feed passes in vapor phase to the adiabatic reactor. Reactor product is heat exchanged with cold feed and sent to water coolers.

Gas remaining after the cooling step is treated for hydrogen sulfide removal and then recirculated. Makeup hydrogen is added to the recycle hydrogen. Liquid product from the high-pressure separator is first flashed at a low pressure in order to remove part of the dissolved gases, and is then treated so as to remove hydrogen sulfide. A final caustic and water wash removes last traces of hydrogen sulfide.

The catalyst for the desulfurization is tungsten-nickel-sulfide. It has high activity and can be regenerated. It can selectively desulfurize cracked naphtha for motor gasoline where saturation of olefins must be minimized in order to retain high octane ratings.

Operation Conditions—Normal operating pressure is between 500 psig and 750 psig. The reactor inlet temperature is normally between 450 F. and 700 F. This temperature depends on the boiling range of the feed stock, the depth of the desulfurization, and the catalyst activity. High space velocities are used so that a small reactor will handle high charge rates. Mole ratio of hydrogen to feed is relatively low.

When thermally or catalytically cracked naphtha is the feed stock, the catalyst is regenerated only every 2 to 4 months. With a straight-run distillate feed stock, the operating period is about 10 months between regenerations Ultimate catalyst life depends upon the physical strength of the catalyst. At one plant catalyst usage was about one pound for each 600 barrels of cracked naphtha processed.

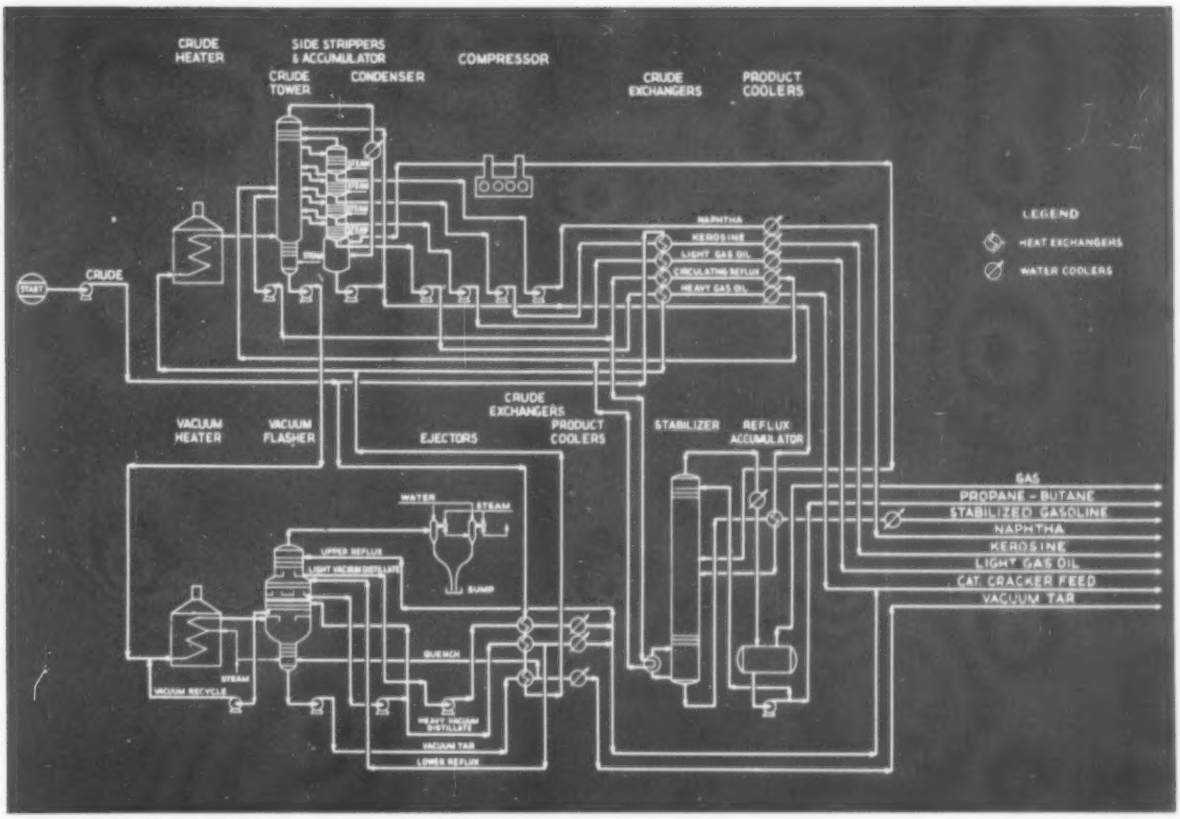
Yields—The liquid volumetric yields from this process are over 100 percent. With cracked naphthas containing 0.4 to 1.5 weight percent sulfur, the reduction in sulfur is about 60 to 70 percent. The resulting products are stable gasolines in all respects.

Economics—The estimated cost of a unit with capacity of 10,000 barrels per stream day is about $2 million, excluding offsite facilities. The direct cost of treating catalytically cracked naphtha is as follows:

Item	¢/B
Utilities	3.2
Chemicals and Catalyst	1.1
Hydrogen	0.6
Labor	1.7
Maintenance	2.4
Overhead	4.1
Total	13.1

Commercial Installations—One at Dominquez, Calif., and one at Wood River, Ill.

Reference—PETROLEUM REFINER, vol 34, no 6, p 118 (June, 1955).



Crude Distillation for Maximum Cracking Feed—

STONE & WEBSTER ENGINEERING CORPORATION—BADGER PROCESS DIVISION

Application—The process provides a means of obtaining maximum catalytic cracker feed by distillation of crude oil.

Products—The products shown are typical of a combination atmospheric and vacuum distillation unit. Catalytic cracker feed consists of atmospheric heavy gas oil augmented by light and heavy vacuum distillates.

Description—Crude oil is preheated by exchange with product and reflux streams before passing through a fired heater to the crude tower. The exchanger arrangement is selected on the basis of distillate draw-off temperatures and fuel value to give maximum economical heat recovery.

Initial fractionation of the crude oil takes place at essentially atmospheric pressure to produce the overhead and the four side streams shown. The overhead passes to a condenser and the net light gasoline product charged to a stabilizer for vapor pressure control. Uncondensed gas is compressed and flows to the stabilizer for recovery of propylene and heavier fractions. Alternatively, the stabilizer might be integrated with the catalytic cracker gas recovery unit.

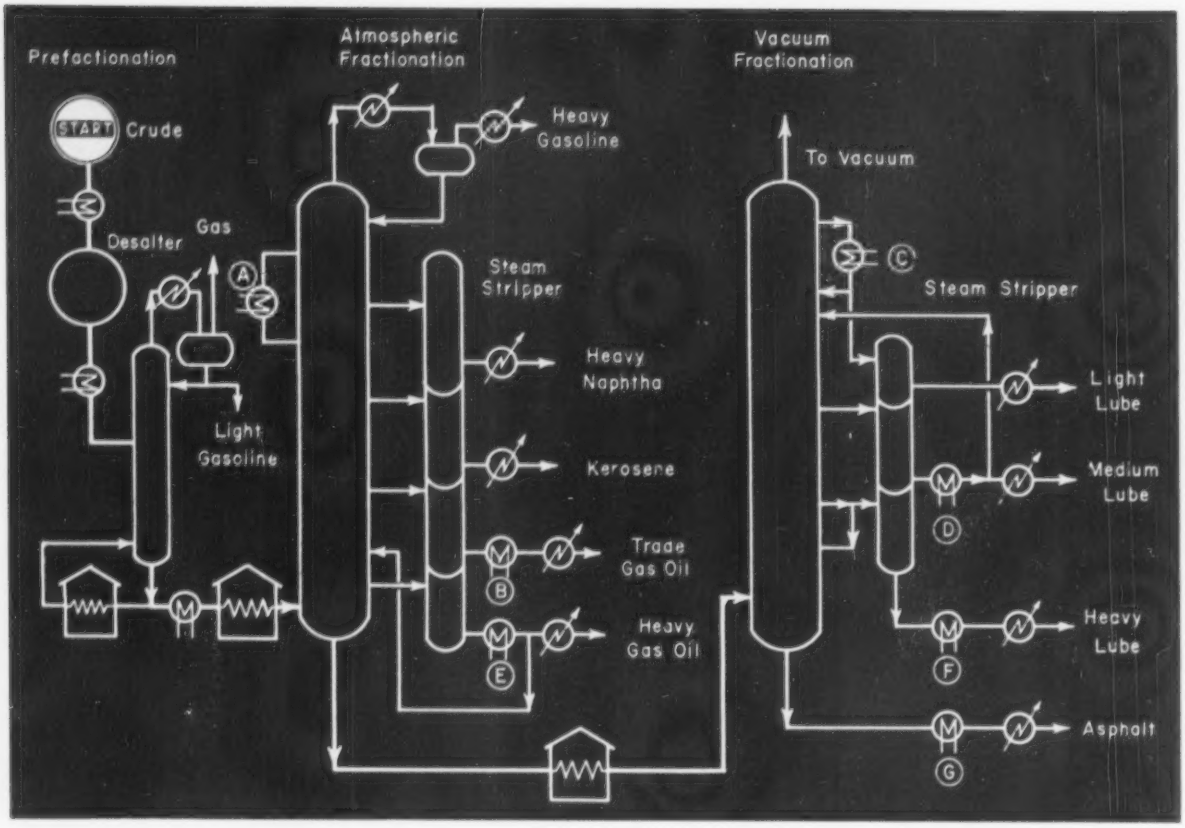
In order to obtain maximum yield of gas oil suitable for catalytic cracker feed, the bottoms from the crude tower is further heated and vaporized in the vacuum flasher. Steam is used to assist vaporization and avoid excessive temperatures which would cause undesirable cracking of the residue. The selection of the optimum operating pressure in the vacuum flasher is influenced by a number of factors, including maximum permissible flash temperature, steam to hydrocarbon ratio and temperature of cooling water for the vacuum condensers or barometrics.

Vacuum distillate is condensed within the tower and withdrawn as two side streams to improve the heat recovery. Both atmospheric and vacuum towers are equipped with circulating reflux systems for heat removal. This arrangement reduces top reflux and tower size, and provides high level heat for crude exchange and reboiler service.

The production of a catalytic cracker feed with minimum carbon residue and metal contaminants is of great importance. Carbon residue can cause excessive coke formation while metal contaminants seriously affect catalyst selectivity and product yield distribution. Provisions for minimizing entrainment in the vacuum tower are therefore imperative. In the unit shown, entrainment is minimized by the use of wash trays and wire mesh located above a properly designed vaporizer. Wire mesh may also be used in the atmospheric tower to improve heavy gas oil quality.

Liquid from the bottom wash tray is pumped back into the feed entering the heater. A continuous flow of oil over the trays below the heavy vacuum distillate is thereby assured, without diluting the vacuum residue.

Vacuum tar is steam stripped and pumped through heat exchangers to storage. This product may be cut-back with a catalytic cycle stock or other low quality distillate for use as refinery fuel. A portion of the cooled tar is returned to the base of the tower to reduce the temperature and prevent coking of the residue.



Crude Distillation for Maximum Lubes—FOSTER WHEELER CORPORATION

Application—The process is applied to the fractional separation of crude oil while producing a maximum yield of lubricating oil stocks.

Description—A simplified flow diagram of the process is shown. The crude picks up heat from some of the other streams within the system by passing through exchangers represented by letters in the flow diagram. The crude flow is first through the reflux recirculating system (A) and is then split into two streams. One stream picks up further heat through heat exchange with the trade gas oil fraction (B) from the atmospheric tower and this preheated stream then moves on to the electrolytic desalter. The other portion of the stream acquires additional heat through heat exchange in the light vacuum gas oil reflux circulating system (C) and it too enters the electrolytic desalting system.

Leaving the desalter, the preheated crude is further increased in temperature by heat exchange in the reflux recirculating system (D). It then passes directly to the prefractionator where water and light gasoline and noncondensable gas are flashed off.

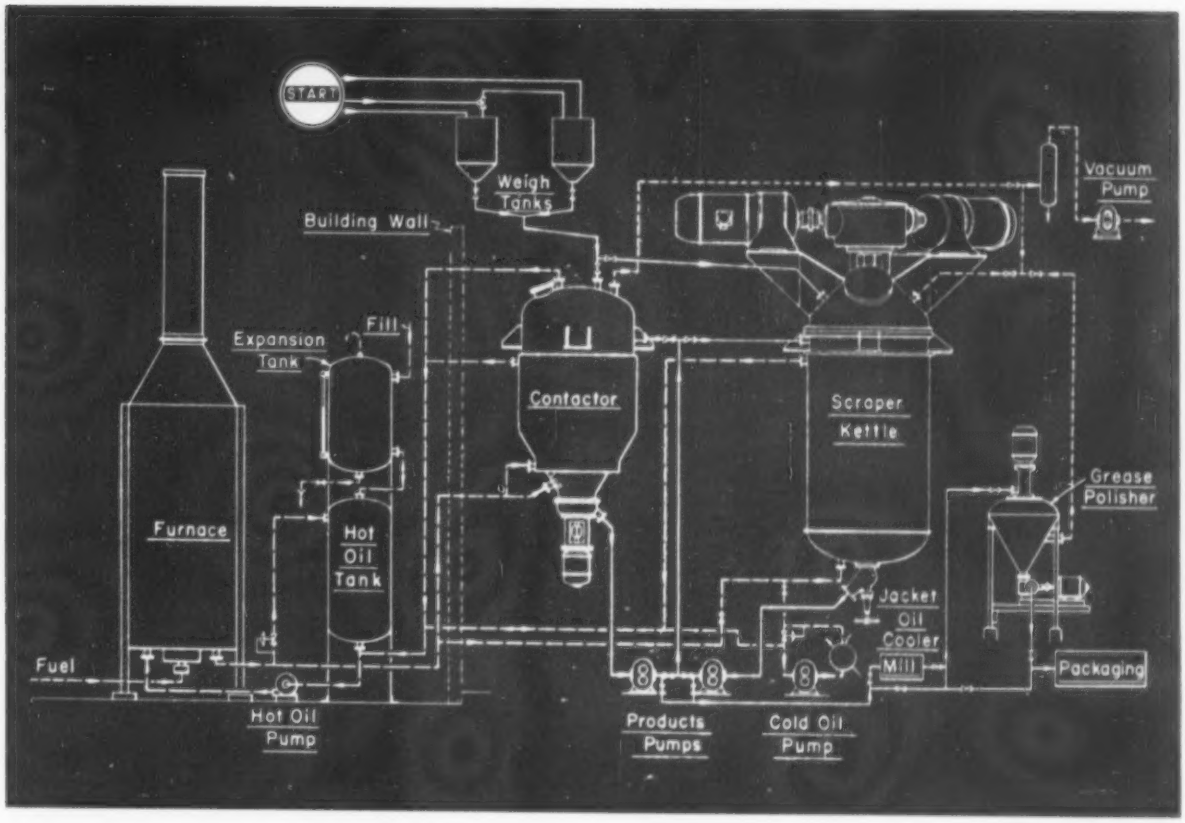
The partially reduced crude is pumped from the prefractionator and this stream is also split into two parts. A small stream passes through a direct-fired heater and re-enters the prefractionator to maintain a desired temperature in the prefractionator. The major portion of the stream leaving the prefractionator exchanges heat in the recirculating reflux system (E). It then passes through the recirculating reflux system (F) picking up more heat and finally obtains its last preheat by passing through an exchanger through which the hot asphaltic bottoms from the vacuum unit are being pumped (G).

The partially reduced crude, now preheated to a temperature of 420 F., enters a direct-fired atmospheric heater in which it is raised in temperature for the purpose of vaporizing the products required from the atmospheric fractionating column. The mixture of reduced crude and vaporized lighter products then passes directly to the atmospheric column where the fractionation into the desired products takes place.

Four sidestream products are removed from the atmospheric column and enter the stripping tower where they are flashed to specification quality. The vapor stripped-off by open steam returns to the column. The stripped sidestreams are cooled and pumped to storage.

The reduced crude from the bottom of the atmospheric column is pumped directly to the direct-fired vacuum heater in which it is raised in temperature to effect vaporization of all but an asphaltic residue. This mixture of vapor and asphalt then passes into the vacuum fractionating column for the purpose of separating the mixture into desired intermediate products.

Three lubricating distillate sidestreams and a residue are drawn from the vacuum column and are pumped through coolers to storage for subsequent processing. The asphalt residue is pumped from the bottom of the vacuum fractionating column.



Grease Manufacturing—STRATFORD ENGINEERING CORPORATION

Application—The process is applied to the manufacture of a wide range of lubricating grease.

Charge—Various compounds of fatty acids and alkali earth metals to form a soap, together, usually, with oils of petroleum source.

Products—Lubricating grease such as calcium, soda, lithium, barium, aluminum, mixed-base and non-soap base grease of desired specifications.

Description—The process involves accurate weight control of all feed components, intimate mixing, rapid heating and cooling, together with milling, dehydration and deaeration, whenever required. The accompanying flow sheet illustrates the process arrangement of the major items of equipment: all-radiant oil circulation heater, high dispersion contactor, scraper kettle and grease polisher.

In general, the required ingredients for producing soap are charged through weigh tanks into the contactor where mixing is induced by an axial-flow impeller located in the lower end of the circulation tube, promoting rapid internal circulation of the entire mass in a large cyclic stream. A heating medium at 400 F. to 600 F. is supplied to the contactor shell and circulation tube jackets by the hot oil circulation pump. An extremely short time cycle (approximately 30 minutes) is required to complete the saponification reaction and, simultaneously, or later if desired, the excess water may be removed through a vacuum line. The remainder of the oil and additives may then be charged into the contactor to complete the manufacture of high penetration grease, or the soap may be transferred into a scraper kettle where these ingredients are added and the grease is finished to specification. The heavier types of grease are normally finished in the scraper kettle owing to the high viscosity which prevails at the proper finishing temperature.

Mixing and circulation of the contents of the scraper kettle are achieved by dual-acting, counter-rotating pumping assemblies arranged to turn over the entire content of the kettle and create inter-stage recirculation between the sets of impellers. The dual-driven scraper kettle is jacketed for either oil heating or cooling. The inside of the kettle shell is smoothly machined to provide rapid heat transfer and effective scraping of the side-wall. The scraper frame assembly carries accurately made, full-floating type scrapers for scraping the straight length of the shell twice per revolution.

The hot oil circulation pump provides 400 F. to 600 F. hot oil to the scraper kettle jacket on the heating cycle. On the cooling cycle the cold oil jacket pump is employed, recycling jacket oil through the cooler, returning to the kettle jacket.

The finished grease from either the contactor or scraper kettle may be packaged directly or further processed through a grease mill and grease polisher, as required by the specifications for the final product.

A typical time cycle required for the manufacture of calcium type grease is 1½ to 2 hours, and for soda-base grease, approximately 2 to 3 hours.

Pilot plant grease manufacturing equipment is normally used in conjunction with the commercial equipment for the purpose of plant guidance and the development of new and improved grease formulations.

Commercial Installations—Many installations of this type have been in operation for a number of years, both in this country and abroad.

Light Hydrocarbon Recovery Processes

Application—Light hydrocarbon recovery processes are applied to refinery gas recovery and gasoline stabilization. The initial refinery application, the setting of gasoline vapor pressure in fractionating column stabilizers, continues to be a major refinery process operation though vapor recovery and fractionation units are now among the essential secondary refinery processes.

Such plants found initial refinery applications as accessories to early thermal cracking units. In many of these cracking units, gas and gasoline were separated at near atmospheric pressures under equilibrium conditions, so that large volumes of valuable butane-and-heavier components were not condensed to liquid. The widespread adoption of the catalytic cracking processes resulted in increased installation of gas-concentration and stabilization facilities for the two-fold reason that catalytic-cracking plants produce large quantities of pentane and lighter materials and that these plants must of necessity fractionate the reactor effluent at low pressure.

Practically all refineries in operation today include some form of gas-recovery and fractionation plant. Their design depends upon the type of refinery process units employed and the amounts of wet gas and unstable distillates to be handled. Each refinery situation requires special consideration.

Charge—Unstable distillates and wet gases from refinery process units.

Products—Gasoline, butylene, butanes, propylene, propane, ethane and methane.

Description—Recovery unit designs vary widely with the desired retention and separation of vapor components. Methods for separation include: (1) fractionating absorbers, (2) low temperature fractionation and (3) adsorption. The most popular method in modern plants is the fractionating absorber as illustrated in the upper flow diagram.

The cracking plant effluent is charged to a main fractionator on which the end point gasoline and all lower boiling components in the product are taken overhead. The liquid overhead is pumped and the gas compressed into a fractionating absorber. In this column, a separation is made between propylene and ethane. The lean oil used is depentanized gasoline from the bottom of the next column; this stream recycling through the two columns. Very high propylene recoveries with little ethane contamination can be obtained. The operation of these units is very satisfactory, the major problem being the fouling of the absorber column with contaminants present in the feed.

The lower diagram represents an application of the refrigeration or low-temperature fractionation process. This plant receives gas and gasoline from a catalytic cracking unit and from a treating unit.

Motor gasoline from the cracking plant is charged to the debutanizer. This column is operated at 185 psig to effect recovery of the major portion of the overhead as liquid. Debutanized gasoline goes to storage.

Aviation gasoline from the treating unit is stabilized at approximately the same pressure, also to obtain maximum recovery of the overhead as liquid, and the stabilized gasoline is pumped to storage. The liquid overhead products from the debutanizer and stabilizer are pumped to a surge tank from which they are sent to the de-ethanizer.

Cracking-unit gas is received at 50 psig. The smaller amount of treating-unit gas, available at lower pressure, is compressed to 50 psig, and these streams are combined with the small flow of overhead gas from the debutanizer and stabilizer, compressed, and discharged into the de-ethanizer which operates at 450 psig. The overhead from this column at 125 F. is water-cooled and then refrigerated, providing reflux at a temperature of 45 to 50 F. The possibility of hydrate formation precludes the use of lower temperatures. The refrigeration unit uses propane as the refrigerant. Refrigeration is effected by the evaporation of plant propane in a kettle-type tubular unit. The propane vapor so produced is compressed and then condensed in the depropanizer overhead product condenser. Net de-ethanizer overhead product gas goes to plant fuel.

De-ethanizer bottoms are depropanized 250 psig. In this column, commercial propane is produced overhead. The bottoms are sufficiently depropanized so that the subsequent butane product will contain less than 1 mol percent propane. The butane tower operates at 100 psig and is designed to make a sharp separation between normal butane in the overhead and isopentane in the bottoms. The bottoms from the butane tower is feed for the isopentane column. This column, operating at 22 psig, is designed to produce overhead an isopentane fraction of 98 percent purity. The bottoms from the isopentane column comprising normal pentane and heavier are pumped to storage and used in motor-gasoline blends. Although two isopentane towers are shown in the flow diagram, it will be noted that process-wise they actually constitute one tower. A split tower was used since the height of a single tower would have been excessive for this particular installation.

For separation and recovery of low concentration gases, the Hypersorption (Union Oil Company of California) process represents an entirely different approach. This adsorption process (no diagram shown) is applicable to the separation and recovery of hydrogen, nitrogen, acetylenes, methane, ethane and ethylene, propane and propylene.

The process employs a moving bed of activated charcoal to adsorb and fractionate components of a gas stream. Feed gas enters through a distributor and flows upward countercurrent to the moving bed of charcoal. Heavier components are preferentially adsorbed and retained on the charcoal while the lightest components disengage at the cooling zone at the top of the tower, and pass off.

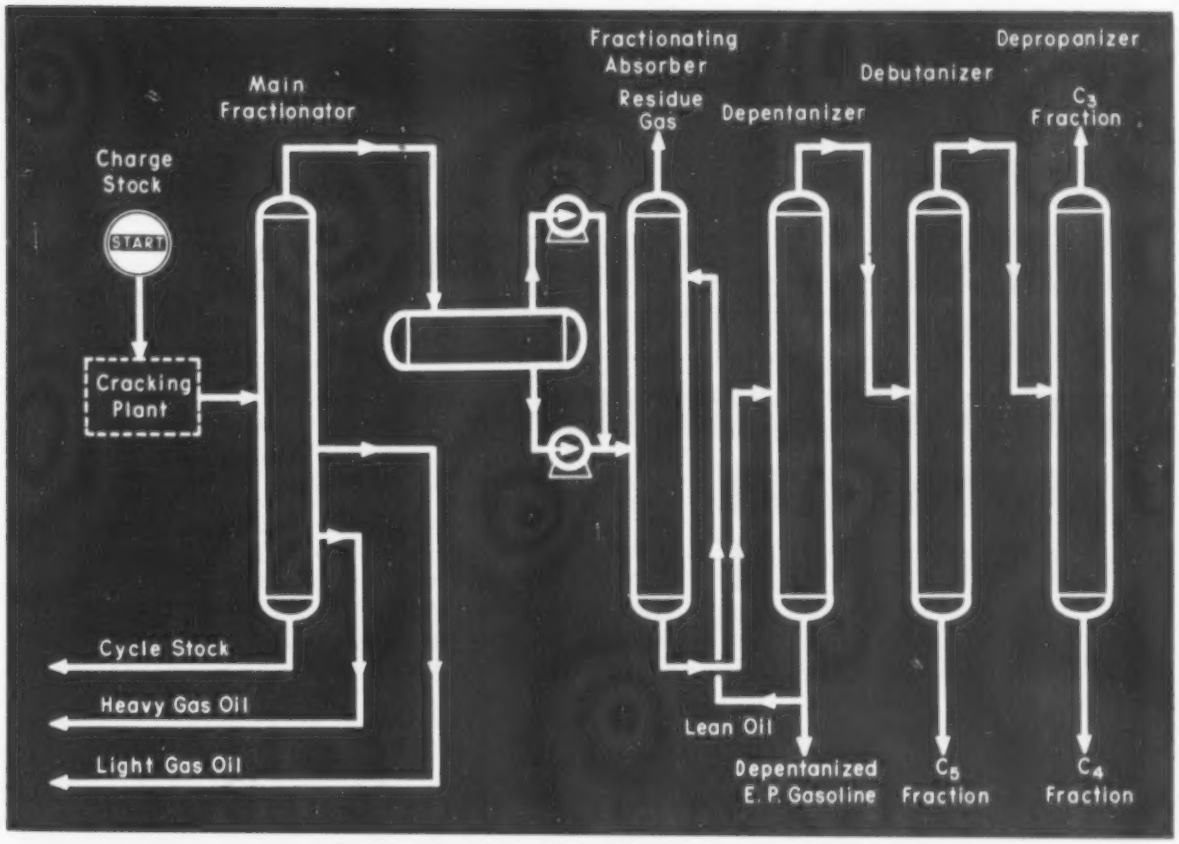
As the charcoal passes downward it is increasingly subjected to a reflux of heavy constituents separated in the stripping zone, which serves to liberate lighter constituents adsorbed on the downward-moving charcoal. A concentration of these latter in the vapor phase results and if desired can be disengaged as a side-cut product gas between the feed and bottom product disengaging sections.

As the charcoal flows past the bottom product disengaging section into a steaming section, it meets an upward flow of steam which liberates the adsorbed heavy components, and these flow upward either to return as reflux or pass out as bottom product.

The charcoal flows from the steaming section into a strippping section wherein it passes down through tubes heated by a circulating heat-transfer medium and through which the steam has passed countercurrent to the charcoal. This section effects the removal of substantially all adsorbed residual material.

The charcoal is transported to the top of the tower by means of a gas lift system, thence into the cooling section wherein the charcoal is cooled to the desired temperature for adsorption.

When necessary a regeneration system is provided to reactivate a side stream of charcoal. This operation is performed at high temperature using steam.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Depropanizer
Main Fractionator
Debutanizer
Residue Gas
Depentanizer
C_3 Fraction
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Cracking Plant
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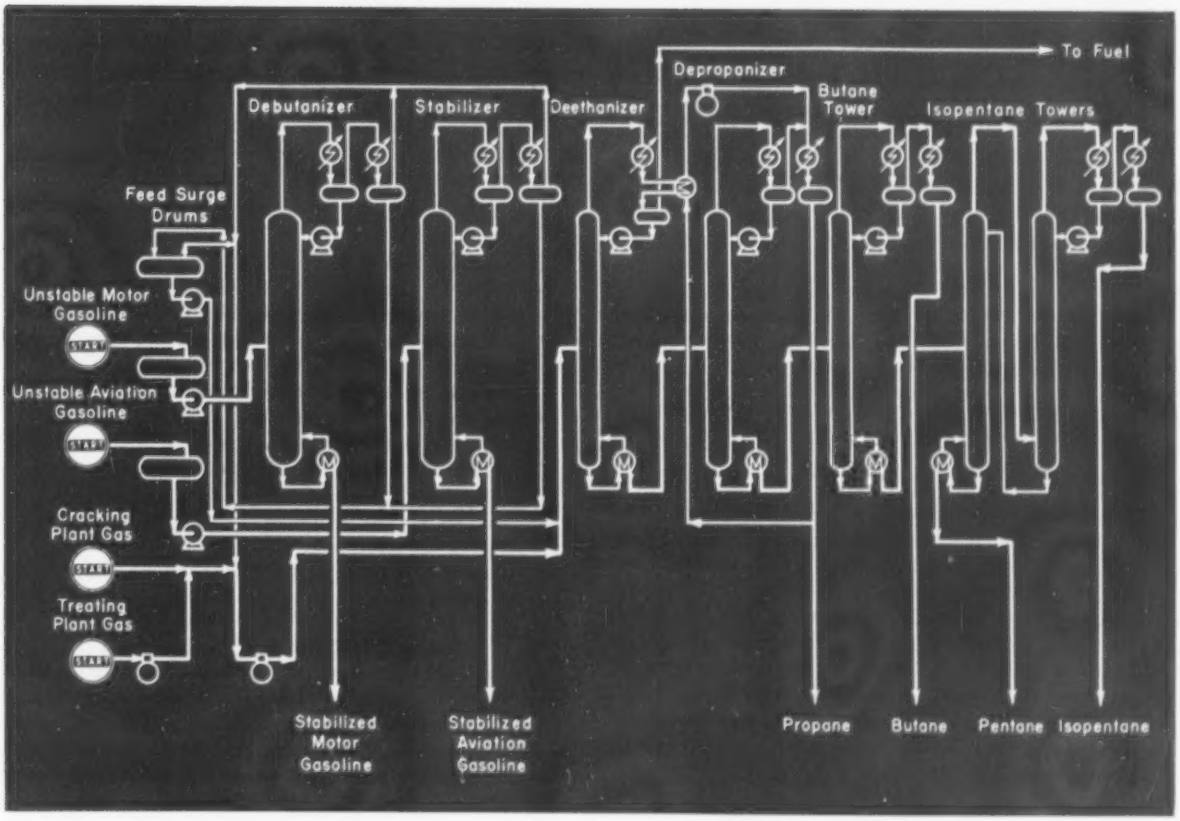
Heavy Gas Oil
Light Gas Oil
Lean Oil
Depentanized E. P. Gasoline
C_5 Fraction
C_4 Fraction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Deethanizer
Butane Tower
Isopentane Towers
Feed Surge Drums
Unstable Motor Gasoline
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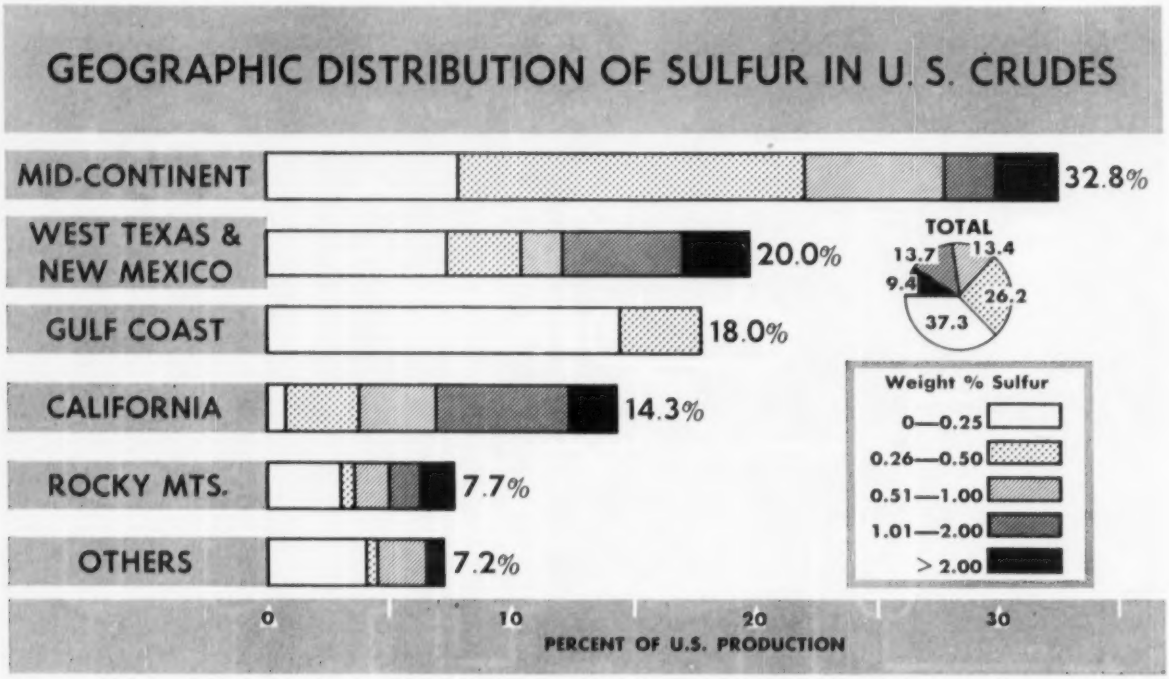


What Hydrogen Treating Can Do

This comprehensive report examines the factors which have ushered hydrodesulfurization into prominence today.

Herbert Kay
Climax Molybdenum Company
New York City

IF THE PETROLEUM REFINER were asked to designate his two most pressing problems, he would probably name the following:

- The competitive race for higher octane gasolines and for better quality petroleum products.
- The high sulfur content of crudes.

These problems are closely related as are the processes which the refiner has selected to help him—namely, catalytic reforming and catalytic hydrogenation, the two most important and fastest growing processes in petroleum technology today. In catalytic reforming, the refiner has both a means of producing high octane gasoline economically and a source of low cost by-product hydrogen for desulfurizing and otherwise upgrading stocks.

Current expansion in catalytic hydrogenation capacity has been brought about by many factors which can be summarized as follows:

1. Depletion of low-sulfur crude petroleum sources.
2. The high sulfur content of newly discovered crude sources.
3. Increased demand for all petroleum products.
4. Consumer demand for sulfur-free products with improved burning characteristics.
5. Increased use of cracking and coking, causing concentration of undesirable compounds of sulfur, nitrogen and oxygen in heavier fractions.
6. Competitive gasoline market.
7. Need for higher octane motor fuels, resulting in expansion of reformer capacity and availability of cheap by-product hydrogen.
8. Need to prevent poisoning of expensive catalysts used in catalytic reforming.
9. Municipal legislation governing smoke control and air pollution.

Crude Oils Contain Contaminants

Of undesirable components in crude petroleum, there is as much as 5 percent sulfur, 2.5 percent nitrogen and 3.5 percent oxygen. There are also traces of metals. Sulfur is by far the most objectionable of these contaminants and its removal is the principal purpose for the installation of catalytic hydrogenation uints. Increased attention, how-

ever, is being given to nitrogen because of its poisoning effect on silica-alumina cracking and platinum reforming catalysts.

Sour crude oils contain relatively large quantities of sulfur in the form of dissolved hydrogen sulfide, alkyl sulfides, mercaptans, thiophenes, etc. In addition to the technological and economic problems caused by these compounds, sour crudes are also objectionaable in that they are dangerous to personnel, are highly corrosive and constitute a fire and explosion hazard.

The refiner, however, can look forward to no escape from the necessity of processing high-sulfur crudes. Better quality crudes are being depleted and the new discoveries are high in sulfur content.

At the same time, the consumer is demanding more and better products. Consumption of petroleum products in 1956 will probably exceed last year's by 5-6 percent. Yet last year only 1.2 barrels of oil were discovered for every barrel produced as compared to the average yearly discovery rate of 1.6 barrels for the ten years, 1946-1955. With the rate of consumption approaching the rate of discovery, the industry must refine to increasingly exacting standards poorer crudes that might otherwise be left in reserve.

In 1955, 36.5 percent of U. S. crude production contained more than 0.5 percent sulfur.

Table 1 shows the distribution of sulfur in crude oils in the U. S. for 1955. As can be seen, California, West Texas and the Mid-Continent area, representing about 68 percent of the country's total production in 1955, bulked largest in output of crudes containing over 0.5 percent sulfur, with 74 percent, 48 percent and 32 percent of production of these areas, respectively, falling in that category. Less than 1 percent of the output of the country's other main producing area—the Gulf Coast, which produced 20 percent of the total—contained over 0.5 percent sulfur.

Comparisons of some of the world's crudes are presented in Table 2. It can be seen that Mississippi and Middle East crudes contain much more sulfur than those from other sources. On the other hand, crude oils from East Texas and the Gulf Coast are nearly free of sulfur. West Texas and Middle East crudes are very corrosive because of their hydrogen sulfide content.

Table 3 shows both the sulfur content and the cost of its removal for various world crudes at the Gulf Coast in 1952. Costs due to sourness and sulfur range from 10 percent to 15 percent of total operating costs.

With such a high percentage of the world's crude containing sulfur in objectionable quantities, the refiner must remove it despite the addition to his operating costs. The many reasons for desulfurization, previously summarized, fall largely into two categories: (1) improved product quality and (2) improved refinery operation.

TABLE 1
Sulfur Content of U. S. Crude Oils (1955)*

Area	% crude in each area containing indicated wt. % sulfur content					% of U.S. Production
	0-.25	.26-.50	.51-1.00	1.01-2.0	> 2.00	
California	5.3	21.0	23.0	37.7	13.0	14.3
Rocky Mts.	37.5	7.8	19.1	15.6	20.0	7.7
W. Tex.-N. Mex.	36.9	15.4	9.2	24.3	14.1	20.0
Gulf Coast	79.9	19.4	0.7	....	....	18.0
Southeastern	22.9	....	31.7	....	45.4	1.6
Mid-Continent	24.3	43.6	17.8	6.8	7.5	32.8
Ill., Ind.-W.Ky.	63.1	36.9	....	....	....	4.3
Mich.-Lima	4.9	34.4	60.7	....	....	.5
Appalachian	100.0	....	....	....	....	.8
Total	37.3	26.2	13.4	13.7	9.4	100.0

***Source:** U.S. Bureau of Mines, Petroleum Experiment Station, Bartlesville, Oklahoma.

Hydrogen Treating Grows

Principal factor in the growth of hydrogenation has been the availability of by-product hydrogen from catalytic reformers. It is estimated that about 1.5 billion cubic feet per day of hydrogen will be available from this source in 1965 if anticipated reformer operating capacity of 2.5 million barrels per day is achieved.[1] While this low-cost hydrogen can be put to other uses by the refinery, such as ammonia or other chemical synthesis, economic considerations so far have generally dictated its use in upgrading petroleum products.

The demand for higher quality products that underpins the boom in reforming is also contributing to expansion in hydrogen treating. Sulfur in gasoline decreases TEL susceptibility; hence its removal is necessary in the interests of higher octane ratings. Moreover, catalytic hydrogen treatment improves the quality of gasoline fuels by selectively hydrogenating diolefins without affecting the benzene ring. This eliminates the gum-forming compounds without wasteful conversion of aromatics to naphthenes.

With color and odor specifications increasingly stringent, hydrogenation of the generally poorer crudes reaching the refinery is necessary to meet quality standards for kerosene, diesel and other fuels, as well as naphthas. Sulfur, for example, affects the color and char value of kerosine.

In addition to the deleterious effect of sulfur content on engine wear and cleanliness, it is objectionable as a source of air pollution. Nitrogen too is being investigated for harmful effects on engines. The strengthening of municipal legislation designed to combat air pollution

TABLE 2—Comparison of Average World Competitive Crude Oils (1954)[14]

	United States	Venezuela	California	Miss. (Heavy)	Typical Coastal	Middle East	West Texas	East Texas
Gravity, A.P.I. (average 1951)	34.7	25.3	26.2	29.8	31.5	35.8	37.2	38.0*
Gravity, main range	16–45	13–40	12–40	13–40	21–37	28–40	25–50	36–40
Sulfur, average percent	0.75	1.36	1.05	1.60*	0.19	1.60	1.38	0.26
Sulfur, percent in 15° A.P.I. oils	1.89	2.22	1.78	3.5	....	....	....	....
Sulfur, percent in 25° A.P.I. oils	1.26	1.39	0.98	1.92	0.17	....	....	....
Sulfur, percent in 35° A.P.I. oils	0.54	0.50	....	....	0.12	1.59	0.65	0.28
Sulfur, percent in 45° A.P.I. oils	0.20	0.11	....	....	....	....	0.17	....
Sour (corrosive)	....	No	No	No	No	Yes†	Yes	No

* Estimate. † Free hydrogen sulfide is usually removed before shipment.

TABLE 3

Operating Costs Due to Sulfur Compounds of Competitive World Crudes at Gulf Coast (1952)[35]

Average Crude Oil	Venezuela	California	Miss.	Typical Coastal	Middle East	West Texas	East Texas
A.P.I. gravity	25 25.3*	25 26.2*	26 29.8*	31 31.5*	36 35.8*	37 37.2*	38 ....
Percent sulfur	1.39	0.98	1.62	0.14	1.42	0.45	0.26
Operating Costs (Gulf Coast 1952):							
Basic investment	4.1	4.1	4.1	4.1	4.1	4.1	4.1
General labor	10.9	10.6	10.7	15.0	12.7	12.6	12.8
Costs due to sulfur	8.0	5.3	9.0	....	8.0	3.5	....
Costs due to sourness	....	....	....	....	2.5	3.5	....
Fuel, power, and water	9.6	9.3	9.4	13.1	11.0	11.0	11.2
Cracking & related oper's	7.1	12.5	15.7	12.1	10.1	12.5	9.7
Upgrading gasoline	4.6	5.0	6.8	3.6	15.7	16.1	9.1
Miscellaneous	2.2	2.3	2.8	2.4	3.2	3.2	2.3
Profit	6.3	6.4	6.3	7.5	7.0	7.1	7.3
Totals, cents per bar	52.8	55.5	64.8	57.8	74.3	73.6	56.5

* 1951 average production. The nearest gravity average analysis was used.

has accelerated adoption of hydrogen treating to reduce or eliminate these objectionable contaminants in petroleum products.

Refinery operations are improved by sulfur removal since it lessens corrosion of equipment, produces products of higher purity, and prevents reforming catalysts poisoning.

The corrosive effect on metals of sulfur compounds in petroleum is well known, contributing a large measure to corrosion cost estimated at about 9 cents for each barrel of crude processed.[2] Under the severe processing conditions prevalent today, desulfurizing poorer crudes may be justifiable on the grounds of savings in replacement parts and downtime even if it were not advisable for other economic and technical reasons.

The relationship between sulfur content of crude and product quality clearly points to the necessity of desulfurizing all stocks for catalytic cracking and reforming units. For example, crude oil should not contain more than 0.5 percent sulfur to produce straight-run and cracked gasoline of less than 0.1 percent sulfur, kerosine of less than 0.13 percent sulfur, and diesel fuel of less than 0.5 percent sulfur.[3]

Apart from the necessity to process less desirable crudes, technological developments within the refinery have added to the sulfur problem in two ways. In their attempts to get more out of each barrel of crude, refiners have placed greater emphasis on coking and related processes. The result, while dropping the average residual fuel yield per barrel of crude from about 25 percent to 15 percent over the last eight years,[4] has meant greater concentration of sulfur in products from these processes than in lighter distillates from the same crude. At the same time, new processes which require feedstocks of higher purity have been developed.

Catalytic reforming, in particular, has brought with it the problem of expensive catalysts, since an estimated 70 percent of U. S. catalytic reformer capacity operating or under construction employs platinum catalysts. They are very susceptible to poisoning by sulfur and other contaminants, and a charge containing less than 0.1 percent sulfur is recommended if the catalyst is to remain selective and active for long periods. Pretreatment is necessary if all marginal feedstocks are to be utilized without a sacrifice in quantity and quality of products. Fortunately, however, the combination of cheap hydrogen for such pretreatment from reformers plus the development of cobalt-molybdena catalysts with long life,

TABLE 4—Growth of Hydrogen Treating in the U.S.A. Since 1955[36]

(Capacity, barrels per stream day)

	1-1-55	1-1-56	Estimated 1-1-57	Estimated Early 1957
Unifining (U.O.P.-Union Oil)	30,250	205,005	237,890	263,875
Hydrofining (Esso)	60,000	113,800	113,800	113,800
Hydrofining (Indiana)	.....	34,600	65,100	87,700
Vapor Phase Hydrodesulfurization (Shell)	23,000	31,000	47,000	47,000
Hydropretreating (Houdry)	.....	13,500	13,500	13,500
Hydrotreating (Texaco)	.....	11,100	18,315	18,315
Hydrodesulfurization (Sinclair)	.....	10,000	10,000	10,000
Hydrodesulfurization (Phillips)	.....	10,000	10,000	10,000
Hydrodesulfurization (Kellogg)	3,000	3,000	3,000	3,000
Diesulforming (Husky)	1,000	1,000	1,000	1,000
Gulfining (Gulf)	.....	.....	80,000	80,000
Hydrodesulfurization (Ashland)	.....	.....	8,500	8,500
Sovafining (Socony-Mobil)	.....	.....	.....	68,000
Undisclosed	.....	.....	25,500	25,500
Total	117,250	433,005	633,605	750,190

resistance to poisons, and ease of regeneration has provided the means of upgrading feedstocks without loss in yield.

How Hydrogen Treating Developed

Hydrogen treating as practiced today is relatively new, although a more severe form of hydrogen treating was used commerically in the U. S. prior to World War II. The modern process—or processes, since there are a number of variations—is the culmination of a long search for an efficient and economical means of removing sulfur. This quest began in the 1930's when the high sulfur content of thermally cracked fuels became significant. The negative effect of sulfur on lead susceptibility became a limiting factor with the increased use of TEL.

Up to this time, treatment of petroleum for sulfur, where necessary, had been carried out primarily to improve odor and reduce corrosion. The processes developed for these purposes depended on chemical treatment to extract objectionable sulfur compounds or convert them to less corrosive and less odoriferous forms. With the new factor of TEL response, the search for processes to decrease sulfur content was pressed.

Catalytic reforming, developed during the war to produce aromatics for high-octane gasoline and TNT, became a commercial refining process as the gasoline octane race gained momentum in the postwar period. It has experienced phenomenal growth because it provides better yields and better quality products than thermal reforming. An added factor in its rapid acceptance is its ability to desulfurize. Fourteen different catalytic reforming processes are now available, and they are equivalent to about 10 percent of the nation's crude refining capacity.

With the installation of cat reformers, refineries at last had the cheap hydrogen needed to solve the desulfurization problem, and the boom in hydrogen treating followed. Catalytic hydrogenation has come into its own within the last three years, revolutionizing treating technology just as cat reforming has revolutionized gasoline octane improvement.

How fast "parent" reforming capacity is growing is shown by the increase in U. S. capacity for catalytic reforming from over 700,000 barrels per day in 1955 to 886,000 barrels per day as of April, 1956. This is exclusive of units planned or under construction which total about 345,000 barrels per day. If predicted capacity of 2.5 million barrels per day in 1965 is attained, catalytic reforming will be equivalent to 30 percent of the nation's refining capacity.

"Offspring" hydrogen treating has followed until there are now 16 different processes in operation. Their capacity, about 30,000 barrels per day in 1954, and about 450,000 barrels per day at the end of 1955, will grow to about 750,000 per day in early 1957 and is expected to reach 1.5 million barrels per day in 1960. Table 4 shows the growth of hydrogen treating capacity and processes since 1955.

Because supported cobalt oxide-molybdena catalysts are the most widely used in desulfurization, the increased consumption of molybdenum is another indication of the rapid growth of hydrogen treating (and catalytic reforming as well). In 1952, the consumption of molybdenum in reforming and hydrogenation catalysts totaled 130,000 pounds. At the end of 1956, consumption will have grown to an estimated 700,000 pounds. By 1965, consumption of molybdenum in petroleum refining is expected to approach 1,100,000 pounds. World consumption of molybdenum for this use is shown in Table 5.

TABLE 5
World Consumption of Molybdenum as a Catalyst in Reforming and Hydrogen Treating*
(Pounds of Molybdenum Consumed)

	1952	1956 (Est.)	1960 (Est.)
Reforming.....	125,000	400,000	500,000
Hydrogen Treating..	5,000	300,000	600,000
Total.....	130,000	700,000	1,100,000

*Source: Climax Molybdenum Company.

How The Processes Work

Methods for desulfurizing and otherwise upgrading petroleum, as has been indicated, range from the older chemical treatments to catalytic hydrogen treating processes in which hydrogen is recycled and make-up hydrogen is added to the system. Within this technological span are catalytic methods which accomplish desulfurization by recycling hydrogen produced by the reforming taking place in the system but without addition of make-up hydrogen, and those which operate without hydrogen.[5]

Since hydrogen treating based on byproduct hydrogen from reformers is the newest and the fastest-growing process, this article will emphasize the technology and application of processes of this type.

Processes Using Reformer Hydrogen—Although these processes vary in details of operation, the chemistry of all is the same: the reaction is a mild selective hydrogenation which converts organic compounds of sulfur, nitrogen, and oxygen into hydrocarbons and removable hydrogen sulfide, ammonia and water. Liquid yields are almost equal in weight to charge stocks and exceed them in volume.

In addition to reactions which remove contaminants, the process selectively hydrogenates olefins to more stable compounds while minimizing saturation of aromatics. Whether the hydrogenation products are paraffins or naphthenes depends on the nature of the olefins in the charge stock.

Typical reactions that occur are as follows:

1. Removal of sulfur
   (mercaptans) $RSH + H_2 \rightarrow RH + H_2S$
   (sulfides) $R_2S + 2H_2 \rightarrow 2RH + H_2S$
   (disulfides) $(RS)_2 + 3H_2 \rightarrow 2RH + 2H_2S$
   (thiophene) $C_4H_4S + 4H_2 \rightarrow C_4H_{10} + 2H_2S$
2. Removal of nitrogen
   (pyridine) $C_5H_5N + 5H_2 \rightarrow C_5H_{12} + NH_3$
   (quinoline) $C_9H_7N + 4H_2 \rightarrow C_9H_8 - C_9H_7 + NH_3$
   (pyrrole) $C_4H_4NH + 4H_2 \rightarrow C_4H_{10} + NH_3$
3. Removal of oxygen
   (phenol) $C_6H_5OH + H_2 \rightarrow C_6H_6 + H_2O$
   (heptene hydroperoxide) $C_7H_{15}OOH + 3H_2 \rightarrow C_7H_{16} + 2H_2O$

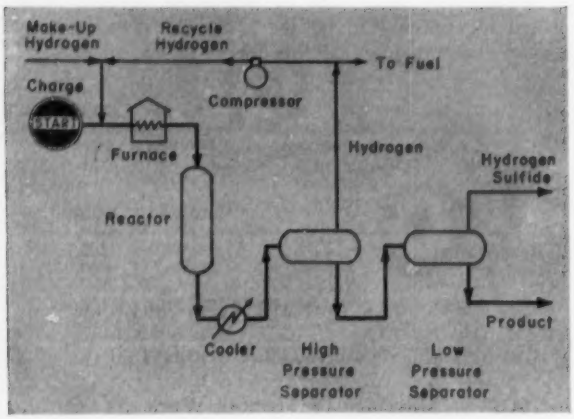


FIGURE 1—Here is a typical process scheme for Hydrodesulfurization.

4. Saturation of olefins

$$CH_2=CR + H_2 \rightarrow CH_2CHR$$

$$R\text{-}CH=CH-CH=CHR' + 2H_2 \rightarrow R(CH_2)_4R'$$

A simplified flow diagram of a typical fixed-bed catalytic hydrogen treating unit is shown in Figure 1. The charge is mixed with recycled hydrogen to which make-up hydrogen has been added, and then preheated in a feed-product heat exchanger or furnace to the proper reaction temperature. This hydrogen-feed mixture then enters the reactor where the desired reactions converting sulfur, nitrogen, oxygen and olefinic compounds into H_2S, NH_3, H_2O plus valuable hydrocarbons occur under the influence of the selective catalyst. Generally this is a vapor-phase reaction, but depending on the application, it may be a mixed phase reaction.

Products from the reactor pass through the feed-product heat exchanger, are cooled, and then go to a high-pressure separator. Here hydrogen-rich gas is separated for recycle, with any excess above process requirements vented to fuel. The hydrogen gas is compressed for recycle, then blended with make-up hydrogen before again mixing with feed.

Liquid from the high-pressure separator flows to a low-pressure separator or stabilizer where dissolved light gases are removed. The stabilized product, depending on the application, is fractionated or used directly.

Practically all catalytic hydrogenation processes employ cobalt-molybdena catalysts which generally are composed of 10 percent molybdenum oxide and less than 1 percent cobalt oxide supported on alumina. These catalysts are often described by different names, but their chemical composition is basically the same in all cases. Highly selective, these catalysts have long life because of their resistance to poisoning, physical ruggedness, and ease of regeneration. Frequency of regeneration varies with the feedstock, the lower boiling stock retaining activity for as long as a year without regeneration. However, the catalyst is outstanding in thermal stability, so repeated regeneration, when necessary, can be accomplished without loss of activity.

Most of the processes are vapor-phase systems employing a fixed catalyst bed. At least one is a liquid-phase system with a moving bed. Principal process variables are temperature, pressure, and space velocity.

Operating temperatures range from 500 to 800 F., with higher temperatures resulting in lower sulfur content in the product. But since catalyst fouling and cracking of feedstock occur at higher temperatures, the lowest temperature is maintained consistent with desired quality of product.

Pressures range from 100 pounds per square inch gage to generally somewhat below 1000 psig. In general sulfur removal and olefin saturation increase with pressure, and catalyst fouling is suppressed. However, the increment of gain in most cases decreases above about 300 psig, and the greater cost for capital equipment and hydrogen consumption in operating at higher pressures does not usually warrant pressures above 750-850 psig.

Space velocity will vary with the feedstock, and will be less for higher boiling stocks than for lighter ones. At lower space velocities, the desired reactions are more complete. If space velocities are too low, cracking and coke deposition result.

Other process variables such as hydrogen recycle rate and the amount of hydrogen sulfide in recycle gas are not as critical. Generally hydrogen is recycled at rates between 500 and 2000 standard cubic feet per barrel, the optimum range from a capital investment viewpoint. Higher rates give less sulfur in the product and lower rates give poor hydrogenation. The hydrogen sulfide in recycle gas has little effect. Whether or not it is necessary to strip it from the hydrogen before recycle depends on the particular process and sulfur content of the feedstock.

Hydrogen treating can be applied to stocks ranging from naphthas to crudes and residuals. Principal application is the treatment of charge stocks to catalytic reformers, with middle distillate treatment accounting for the next largest total capacity. Other stocks so upgraded include cat cracker charge stocks and lubricating oils. The treatment of residual stocks and crudes, though not yet widely practised, holds many economic incentives to be covered more fully later. Here, only the physical improvements in quality will be discussed.

Stocks upgraded to permit charging to catalytic reformers include straight-run naphthas abnormally high in contaminants as well as thermally cracked naphthas and coker gasolines. Treatment removes the contaminants and improves the odor, color and TEL susceptibility of the stocks. Other naphthas such as specialty solvents are also treated to give premium products with improved color, odor and stability.

Middle distillates are treated to produce diesel oils and heating oils which have superior burning characteristics, color stability and resistance to sludging; and to produce specialty products. Another principal purpose is improvement of the cracking characteristics of cat cracker charge stocks and removal of catalyst poisons from such feedstocks.

Straight-run or cracked heavy distillates can be upgraded by hydrogen treating into quality distillates or cat cracker charge stocks of improved characteristics.

Lubricating oils of improved color and reduced carbon residue and sulfur are obtained by hydrogenation of deasphalted oil. Waxes can be similarly improved.

Not only can reduced crude petroleum be improved by hydrogen treatment, but even shale oil, which is unusually high in nitrogen and difficult to refine by conven-

tional means, can be upgraded into distillates for fuel or cat cracker feed. Though the latter is of limited commercial value now, it will become increasingly important, and illustrates the versatility of the process.

Following are brief descriptions of the individual processes. Important details of these processes are summarized in the box presented later.

Unifining,[6] developed by Universal Oil Products Company and Union Oil Company of California, is the most widely used of all the catalytic hydrogenation processes. Versatile, it is applied to a wide variety of petroleum fractions ranging from gasolines to heavy vacuum distillates. Process conditions will vary with the particular charge stock and product desired.

Unifining is very effective in removing sulfur with liquid yields of 100 percent or better. For example, a California mixed thermal and straight-run heavy naphtha charge with a sulfur content of 1.9 percent by weight was Unifined to a sulfur content of 0.008 percent by weight with 101 percent liquid yield. Similarly, the sulfur content of a Wyoming diesel oil was reduced from 2.1 percent by weight with a liquid yield of 100 percent after Unifining.[6]

In January of this year, it was reported there would probably be about 30 commercial installations on stream with a total capacity of about 260,000 barrels per stream day. By July of this year an additional 260,000 barrels was reported to be under construction. The units now in operation and those under construction will Unifine diesel oils, cracked naphthas, cycle stocks, aromatic distillates, vacuum distillate oils, straight run gasolines, thermally cracked and coker naphthas, straight run kerosines, and thermally cracked gas oils.

Hydrobon was the name originally given to Universal Oil Products' process before a patent pool was arranged with Union Oil Company.

Hydrofining,[7,8,9,10,11,12,13] developed by Esso Research & Engineering Company, is the second most important process in extent of application. As is Unifining, it is a very versatile process and is used to desulfurize, improve stability, reduce odor, prevent formation of gum and carbon residue and otherwise improve the quality of many types of stocks.

Yields are 100 percent by volume. For most purposes, cobalt and molybdenum oxides on alumina are effective as catalysts. But other metal oxides are also used.

Hydrofining is particularly adaptable to desulfurizing and upgrading catalytic cracking and reforming stocks. Virgin naphthas are being treated to reduce sulfur from 0.12 percent to 0.01 percent or lower with a leaded octane improvement of up to 10 numbers. Sulfur reduction to as low as 1 ppm. can be achieved for platinum catalyst reforming feeds. In general, the process will upgrade poor stocks previously considered uneconomical for desulfurizing.

Trickle Hydrodesulfurization,[14,15,16,17] developed by Royal Dutch-Shell, derives its name from the fact that the liquid charge, together with hydrogen, trickles downward through a fixed bed of cobalt-molybdenum-alumina catalyst. The main feature of the process is that it operates at low hydrogen recycle flow rates. As a result, there are savings in operating and capital costs since size and power consumption of hydrogen recycle compressors are reduced and since less heat has to be transferred through feed/product heat exchange, requiring less heat-transfer equipment.

The reactor contains a number of catalyst beds so that cold charge oil can be injected between beds to take up the heat of the exothermic hydrogenation reaction. The number of beds depends upon the sulfur content and the degree of desulfurization desired.

A large variety of high sulfur stocks such as straight-run and catalytically cracked gas oils and shale oil can be treated. Vacuum distillates can be desulfurized too, because vaporization is not necessary in the trickle process. Using feeds containing as much as 2.5 percent sulfur, a reduction to 0.4 percent is possible. This 90 percent desulfurization was achieved at a feed rate of over 5000 barrels per day. The supported cobalt-molybdena catalyst gave very little hydrogenation of aromatics at this high degree of removal.

Vapor Phase Hydrodesulfurization,[18] developed by Shell Development Company, is perhaps the oldest of the hydrogen treating processes. Two units have been operated by Shell Oil Company for nearly ten years. During the war, they were used to selectively desulfurize cracked naphthas in order to give products meeting aviation gasoline specifications.

The operation is carried out in the vapor phase with low hydrogen-to-oil ratios. Catalyst regeneration may be required at periods ranging anywhere from 2 to 10 months depending on the feedstock. Catalyst life where cracked naphthas are processed is limited by the disintegration of the catalyst. Catalyst usage at a plant whose capacity is 12,000 barrels per stream day is about one pound for each 600 barrels of naphthas processed.

The most promising applications of vapor-phase selective hydrodesulfurization appear to be in the selective desulfurization of cracked naphthas containing 0.4 percent to 1.5 percent by weight of sulfur to make them more suitable for motor fuel blending.

Diesulforming,[19,20,21] developed by Husky Oil Company, is primarily used to desulfurize cat reformer charge stock. However, the process also removes nitrogen and oxygen and provides the additional advantages of color, odor, and cetane number improvement. The units are of rather simple design and are closely integrated with catalytic reformers from which the hydrogen is supplied. Sulfur removal varying from 79 percent to 80 percent, depending on the charge stock, has been obtained with Diesulforming.

In one single 1000 barrel per day commercial Diesulforming unit the molybdenum type catalyst has maintained its activity for about 20 months without regeneration. With repeated regeneration possible, it is expected to last indefinitely under normal operating conditions.

The Hydrodesulfurization Process[22] of Sinclair Refining Company uses a cobalt-molybdena-on-alumina catalyst of high activity. Sinclair developed the catalyst jointly with the National Aluminate Corporation.

Gulfining[23] (Gulf Research and Development Company) is a desulfurization process employing a cobalt-molybdenum type catalyst which eliminates the need for

A Quick Run-Down on

PROCESS	Licensor or Developer	Feedstocks	Process Conditions Temp. (Deg. F)
Autofining	The British Petroleum Co.	Kerosine extracts, tractor fuels	700-800
Diesulforming	Husky Oil Co.	Primarily reformer feed	600-800
Gulf HDS	Gulf Research & Development Co.	Crudes, residuals	800-850
Gulfining	Gulf Research & Development Co.	Fuel oil, distillates	
Hydrobon	Universal Oil Products Co.	Reformer feed, burning oil	to 800
Hydrodesulfurization	Ashland Oil Refining Co.	Middle distillates	
Hydrodesulfurization	The M. W. Kellogg	Reformer feed	
Hydrodesulfurization	Phillips Petroleum Co.		
Hydrodesulfurization	Sinclair Refining Co.	Fluid catalytic light cycle oil, straight run naphtha	580-780
Hydrodesulfurization	Standard Oil Co. (Ind.)	Distillates, burning oil	
Hydrodesulfurization	Sun Oil Co.	Lube oils	
Hydrofining	Esso Research & Engineering Co.	Various	400-800
Hydropretreating	Houdry Process Co.	Reformer feed	700-775
Hydrotreating	The Texas Company	Reformer feed	
Sovafining	Socony-Mobil Oil Co.	Light & middle distillates	
Trickle Hydrodesulfurization	Royal Dutch/Shell	Gas oil, virgin gas oil	660-730
Unifining	Universal Oil Products Co. Union Oil Co. of Calif.	Various	to 800
Vapor-Phase Hydrodesulfurization	Shell Development Co.	Catalytically cracked naphthas light straight run distillates	450-700

doctor sweetening in producing heating and diesel fuels with no objectionable odor. Eighty to 90 percent removal of sulfur from either virgin or catalytically cracked fuel-oil distillates is possible.

Gulf HDS[24] is a Gulf Research & Development process combining hydrocracking and desulfurization which has been applied in pilot plant to the upgrading of crudes and residues. Desulfurization of up to 93 percent has been accomplished. The catalyst has been shown to be insensitive to the effect of metal contaminants. It maintains good activity after repeated regenerations in spite of a significant deposition of metal contaminants.

Hydropretreating,[25] developed by Houdry Process Corporation for operation in conjunction with Houdriformers, is used to desulfurize and upgrade cat reformer feedstock. The process is reported to employ a Houdriforming Type 3 catalyst containing platinum.

Among other processes are *Hydrotreating* (The Texas Company), *Sovafining* (Socony Mobil Oil Company), and unnamed processes of Standard Oil Company (Indiana), Phillips Petroleum Company, M. G. Kellogg Company, and Ashland Oil & Refining Company.

Hydrogenation Without Make-Up Hydrogen—Catalytic hydrogen treating in which no outside hydrogen is required, but hydrogen produced within the system is separated and recycled is the forerunner of the processes now undergoing expansion. One such process, called Autofining, is the development of British Petroleum Company.

Autofining[5,26] is a combination of controlled dehydrogenation of naphthenes and hydrogenation of sulfur compounds. The former is the source of hydrogen for the desulfurization.

The catalyst used is a mixture of cobalt and molybdenum oxides on alumina. It can be regenerated easily with steam-air or inert gas-air mixtures. With light feed stocks (straight run naphthas and kerosines), catalyst regeneration is necessary only after periods greater than 1000 hours. With the heavier feed stocks (diesel oil), regeneration is required after 200 to 400 hours. The molybdenum catalyst in one Autofining installation showed no loss in desulfurizing ability and physical strength after two years' use at the rate of 3500 barrels per stream day.

Product recovery in Autofining is almost 100 percent by volume. Any losses are usually less than 0.1 percent by weight. Approximately 70 cubic feet of hydrogen per barrel is required for feedstock with a sulfur content of 1.0 percent.

Catalytic Desulfurization Without Hydrogen—Several processes which accomplish desulfurization catalytically without the use of hydrogen were predominant prior to the current boom in hydrogen treating. Among these are the Gray Process and Percolation Filtration.

Gray Desulfurization[27,28] uses Fuller's earth as a catalyst to remove sulfur from lighter petroleum fractions. Desulfurization is effected by passing the vaporized fractions through the catalyst bed at temperatures of 550 to 850 F. Sulfur removal ranges between 97 and 99 percent depending on the sulfur content and the feedstock. An increase in clear octane number and lead susceptibility

the Processes Available

Process Conditions		Catalyst	No. of Units (est.)	Capacity BPSD (est.)
Pressure (psig)	Space Velocity Vol. Charge per Vol. Catalyst per Hr.			
100-200	2-5	Cobalt oxide-molybdena on alumina	3	7,500
300-500	0.5-5	Molybdenum type	3 (1957)	3,000
500-1000	0.5-2.0			
		Cobalt-molybdenum	2 (1957)	80,000
Below 1000			1	13,000
200-800	2.0-8.0	Molybdenum type Cobalt-molybdenum on alumina	1 1 1 2 1	8,500 3,000 10,000 10,000 16,000 1,500
50-800	0.5-16	Generally cobalt & molybdenum oxides on alumina	25 (early 1957)	200,000
400	10-20	Platinum type	2	13,500
			1	10,000
			3 (1957)	68,000
300-750	1.3-3.6	Cobalt-molybdenum-alumina	3	15,000
Below 1000		Cobalt-molybdena on alumina	31 (early 1957)	260,000
500-750	"high"	Tungsten-nickel-sulfide	4 (early 1957)	47,000

accompanies the desulfurization. Eleven units were installed prior to the advent of catalytic hydrogenation.

Percolation Filtration,[29] commonly called the Perco Process, was developed by Minerals & Chemical Corporation of America. It finds application in desulfurizing naphthas and finish-refining of lube oils and other fractions. The charge is filtered through a catalyst which, depending on the feedstock, is either Fuller's earth or bauxite. There is an improvement in color, odor and stability. Sulfur content in aviation blending naphthas was decreased from 0.05 to 0.005 percent in one case. There are about 53 commercial installations.

Chemical Treating—Other processes for controlling sulfur and other contaminants are generally classified as chemical treatments. Once widely used, these are being supplanted by catalytic hydrogen treating processes. They generally function by extracting the objectionable contaminants, by converting them to less deleterious forms, or by preventing the formation of objectionable compounds. They can generally be classified as four types:

- Acid Treatment
- Sweetening
- Solvent Extraction
- Additives.

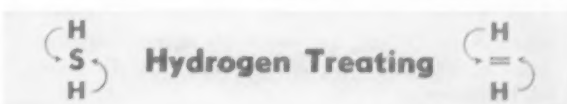
Also to be discussed are chemical methods for removal of hydrogen sulfide formed in hydrogen treating.

Acid treating is usually carried out by one of two acids. A description of each is given in the following paragraphs.

Sulfuric acid treating[4,27] decolorizes, deodorizes and reduces the sulfur content of such petroleum products as gasoline, kerosine, solvents and distillate and residual fuels by oxidizing mercaptans to disulfides soluble in the acid. Sulfides and disulfides already present in the charge are also removed by sulfuric's preferential solvent action. Redistillation, which often follows, further reduces the sulfur content as higher boiling sulfides concentrate in the bottoms.

Its many disadvantages now limit its application. They are:

- Poor selectivity. Sulfuric acid attacks valuable constituents of petroleum as well as the deleterious compounds it removes. Control of treating conditions limits this product loss, but only at a sacrifice in conversion of undersirable compounds.
- Decrease in product quality—e.g., treated gasoline has a lower octane rating.
- High acid cost.
- Problems related to disposal of waste products.
- Incomplete removal of some sulfur compounds.
- Redistillation is necessary in some cases to remove certain sulfuric acid compounds decomposing over 270 F.
- Need to neutralize. Because petroleum products are unstable in the presence of acid, treated products must be washed with caustic, although finely divided clay is



sometimes used to neutralize the remaining acid.

Hydrofluoric acid treating, which exerts a selective solvent action on sulfur compounds, has been shown to be more selective than sulfuric acid. It does not, however, oxidize mercaptans to disulfides.

Sweetening processes have principal value in their deodorizing ability since they merely oxidize mercaptans to disulfides with no actual reduction in sulfur content. In treating gasoline, they offer no improvement in lead susceptibility and may cause a decrease in octane number.

Doctor Sweetening,[1,28] a process available from The Lummus Company, is one of the oldest processes for sweetening gasoline, kerosine and solvents. The sour gasoline is reacted with sodium plumbite which converts mercaptans to lead mercaptide, in turn converted by addition of sulfur to alkyl disulfides and lead sulfide. The lead sulfide can be regenerated to sodium plumbite by treating it with caustic soda in a stream of air.

This process consumes lead oxide, caustic soda and sulfur. An important factor in its operation is the skill required in adding sulfur and other materials. If too much sulfur is added, there will be an excess in the gasoline, making it very corrosive.

The lead sulfide sweetening process treats gasoline containing mercaptans with lead sulfide in the presence of air. Here the treating and regeneration steps of doctor sweetening are combined in one step to convert the mercaptans to disulfides.

Another variation of the doctor sweetening process is the combination of lead oxide and sodium hydroxide, as a solid reagent deposited on an absorbent.

The hypochlorite sweetening process[27] employs sodium or calcium hypochlorite as oxidizing agents to convert mercaptans to disulfides. Partial conversion of sulfides and disulfides to water-soluble sulfones and sulfoxides also occurs, resulting in some removal of sulfur as well as sweetening. An alkali wash is necessary to remove some acid chlorides formed in the process. Because of the cost of chlorine and this extra wash, the application of this process has been limited.

The copper chloride sweetening process[30] utilizes copper chlorides to oxidize the mercaptans to disulfides, and air or oxygen to regenerate the reagent. It is usually applied to gasoline containing less than 0.05 percent mercaptan sulfur. A slight decrease in octane number, but no decrease in lead susceptibility, results. If traces of copper are not removed after treatment, they cause discoloration and loss of inhibitor response in gasoline.

There are three variations: fixed-bed, slurrry and solution. An inert carrier supports the reagent in the first two; in the latter, the reagent is in an aqueous solution.

The sweetening reaction is

$$2\,CuCl_2 + 2\,RSH \rightarrow 2\,CuCl + RSSR + 2\,HCl$$

The regeneration reaction is

$$2\,CuCl + 2\,HCL + \tfrac{1}{2}O_2 \rightarrow 2\,CuCl_2 + H_2O$$

These two reactions proceed simultaneously as the oxygen for regeneration is present or has been added to the gasoline. As can be seen, water is formed which, if the mercaptan content of the gasoline is high, may exceed the amount soluble in the gasoline and accumulate in the reagent. This interferes with either the slurry or mixed-bed variants, so feeds must be dried or heated to raise the solubility of water in gasoline prior to treatment.

In the solution process, such as the Perco, the copper chloride is regenerated with air. In the slurry processes and fixed-bed processes pure oxygen is used, although air can be used in some cases. The oxygen is dissolved in the gasoline before treatment. Among variants are the Linde and Airco-Hoover slurry processes and the UOP fixed-bed process.

Solvent Extraction Processes, sometimes referred to as subtractive refining, actually remove mercaptans.

Caustic scrubbing[4,27,30] using very strong sodium hydroxide or potassium hydroxide can remove some of the mercaptans, as sodium or potassium mercaptides. Recovery of caustic and isolation of the contaminant can be accomplished by air oxidation or steam stripping. Since the acidity of mercaptans diminishes as the molecular weight increases, this treatment removes most of the low-molecular weight mercaptans but very little of the heavier ones. However, the efficiency of caustic scrubbing can be increased by the addition of solvents, which increase the solubility of the mercaptans.

The Tannin-Solutizer Process[29] as developed by Shell Development Company, uses strong potassium hydroxide solution containing a small amount of tannin and mercaptan solubility promoters such as fatty acids and/or alkyl phenols. The tannin catalyzes the oxidation of mercaptans to disulfides in the regeneration step after the mercaptans have been extracted. There are about 30 commercial installations.

The Mercapsol Process,[29] developed by The Pure Oil Company, uses an extraction agent consisting of an aqueous solution of sodium hydroxide with mixtures of naphthenic acids and alkyl phenols as solubility promoters. The process is suitable for straight-run, thermally cracked and thermally reformed gasolines. It can remove 90 to 95 percent of the sulfur content and improve TEL susceptibility and odor.

Meet the Author

HERBERT KAY, manager of catalytic development for Climax Molybdenum Company, is responsible for developing uses of molybdenum in corrosion inhibitors, intermetallic compounds and ceramics as well as in catalysts. He joined Climax about a year ago, when the company established its Chemical Development division. Previously he had been with Pittsburgh Consolidation Coal Company. As a group leader in that company's Research and Development division, he made major contributions to the development and design of new commercial coal-conversion processes. Kay's other experience includes petrochemical-process research for Stanolind Oil and Gas Company and development of liquid fuels from coal and oil shale at the Naval Research Laboratory. A chemical engineering graduate of Pennsylvania State College, he also holds master's degrees from both Penn State and Massachusetts Institute of Technology.

The Unisol Process,[29] as developed by Universal Oil Products Company, uses methanol as a solubility promoter with a solution of sodium hydroxide to extract mercaptans from gasoline and higher boiling petroleum fractions. Sulfur content reduction of better than 99 percent is possible in addition to a slight increase in octane number.

The Dualayer Process,[30,31] developed by Magnolia Petroleum Company removes mercaptans as well as certain phenolics from distillate fuel oils and gasoline. The treating agent is concentrated caustic, generally potassium hydroxide. The process is based on the principle that highly concentrated aqueous solutions of caustic, upon saturation with phenolics, separate into two layers, of which the upper contains sodium or potassium phenates, and the lower layer is uncombined caustic free of phenolics. This upper acid-rich layer selectively removes mercaptans.

In practice, cresylic acids are present in petroleum distillates from which mercaptans are to be removed in sufficient quantity so that normally no organic acid need be added. The caustic (50 percent KOH) is mixed with the fraction to be treated and the treated oil and spent caustic solution separated. The upper layer containing the dissolved salts of the organic acids and mercaptans is discarded, and the lower layer, which is largely dilute caustic, is concentrated for reuse. Since the stripper temperature in the caustic concentrator is the only variable in the system (the KOH being in equilibrium with the potassium cresylate-rich solution), this process gives excellent control of mercaptan removal. One unit with a capacity of 30,000 barrels per day is in operation for treating fuel oils.

The Sulfur Dioxide Extraction Distillation,[29] the Edelean process, can remove sulfur compounds although its primary use is in separating aromatic hydrocarbons from long-chain hydrocarbons. Purpose of the treatment can be either to upgrade oil or to recover valuable aromatics. The charge is mixed with cold liquid sulfur dioxide, and separation into two layers occurs. In kerosine treating, the lower layer or extract contains the aromatic hydrocarbons and sulfur-bearing compounds dissolved in sulfur dioxide; and the upper layer, the remaining hydrocarbons. A disadvantage of the process is that the sulfur compounds are hard to separate from the aromatics. If the distillate contains large amounts of sulfur, so will the extract, which then has little value. Sulfur dioxide extraction plants have a total operating capacity of about 200,000 barrels per day.

Furfural Refining[29] was developed by Texaco Development Corporation to extract undesirable components including sulfur compounds from petroleum lubricating oil stocks and gas oils with furfural as the solvent. Sulfur content in a gas oil from a West Texas crude, for example, can be reduced from 1.12 percent to 0.49 percent. There are about 50 units in operation.

Additives or inhibitor sweetening agents are primarily materials used to protect oxidizable hydrocarbons in storage and play only a minor part in the over-all upgrading processes under consideration here. But their use was once considered a general cure-all for quality improvement programs.

In gasoline treating, phenylenediamine type of compounds, which can be used only with gasolines of low mercaptan content, are sometimes added after scrubbing as an antioxidant to prevent gum formation.

Although additives are not very suitable for kerosine, hydroquinones may be used to destroy color-forming bodies.[4]

Metal salts can be used as dispersants in fuel oils to keep any sediment from settling in storage. Alkali and alkali earth sulfonates have the additional ability of decreasing the formation of residues.

Primary amyl nitrate is being used to upgrade fuel oils to diesel oils.[4]

Removal of hydrogen sulfide becomes more important with the advent of hydrogen treating. Ordinarily the problem would not exist since H_2S is distilled off in the lighter fractions and any amounts present in gasoline fractions are so low that a simple caustic scrubbing suffices. Among the processes in use for H_2S removal are the following:

Phosphate desulfurization,[29] developed by Shell Development Company, uses a solution of tripotassium phosphate to react with the hydrogen sulfide. The reaction is reversible and regeneration of the phosphate may be accomplished by steaming. A feature of the process is that hydrogen sulfide of high purity is recovered and may be used for producing elemental sulfur or sulfuric acid. About 50 plants are in operation.

The Girbotol Process,[29] developed by The Girdler Corporation, utilizes ethanolamines to remove hydrogen sulfide from gases and liquid hydrocarbons. Several hundred plants are in operation.

The Glycol-Amine Process,[29] developed by The Fluor Corporation, combines ethanolamines with ethylene glycols for the continuous removal of hydrogen sulfide. Dehydration is possible with this process.

Economics of Hydrogen Treating

Catalytic reforming of naphtha has been both the stimulus—in its need for feedstocks low in sulfur and nitrogen—and the means—in making available by-product hydrogen for sulfur and nitrogen removal—by which hydrogen treating processes have become established in petroleum refineries. And the availability of low-cost hydrogen remains the one most important economic factor influencing the hydrogen treatment of most petroleum fractions.

What is true of treating catalytic reformer feedstocks is even more important in the treatment of stocks heavier than gasoline where the hydrogen-to-sulfur ratio in the stocks is less favorable. The major limitation on the extent to which middle distillates, cat cracking charge stocks, lubricating oil stocks, crudes and residuals will be hydrogen-treated in the future is availability of cheap hydrogen.

In mild hydrogenation, such as is involved in the processes under discussion, the bulk of the hydrogen is consumed in satisfying the stoichiometric requirements of sulfur. However, a considerably large amount is consumed

in the saturation of olefinic compounds. The latter reactions, and consequent hydrogen consumption, may be minimized by the development of a catalyst which will selectively hydrogenate sulfur and nitrogen compounds while leaving the olefins unaffected.

The many variables which are involved in catalytic hydrogen treating make it almost impossible to compare hydrogen requirements of the different processes. However, in view of the importance of hydrogen consumption, it is of interest to note process requirements reported for different charge stocks and product objectives as summarized in Table 6. But these data must be regarded with care. For example, in comparing the preparation of catalytic reformer feedstock by Unifining, an Oklahoma cracked gasoline containing only 0.12%S required almost as much hydrogen to reach an 0.008%S level as a California mixed thermal and straight-run heavy naphtha containing 1.9%S. The reason for this apparent discrepancy lies in the high olefin and arsenic content of the Oklahoma-based cracked material.

Cheap hydrogen will be available from catalytic reformers to the extent of about 1.5 billion cubic feet per day by 1965. At the present time, hydrogen in excess of that required for pretreatment of catalytic reformer charge stocks is being used for a variety of purposes:

1. Sweetening and gum-stabilizing of cracked gasoline.
2. Improved color, odor, stability, burning characteristics, cetane numbers, sulfur and nitrogen content of middle distillates.
3. Preparing premium cat cracking charge stocks.
4. Preparing premium fuel oils.

Naphtha Treating—Most of the available processing cost data are for the treatment of naphthas to produce satisfactory catalytic reformer charge stocks, aviation base stocks or motor fuel. The following cost data are of interest:

Charge Stock	Product	Plant Size BPSD	Plant Cost $/BPSD	Op. Cost ¢/Bbl.
Blended cracked + S.R. naphthas (210-500 F)	Cat. ref. feed & fuel oil	5,000 (Unifining)[6]	150	10.7
Cracked naphthas or heating oil		10,000 (Hydrofining)[11]	90	10–15
Cat. cracked naphtha (250–420 F)	Aviation base stock	10,000 (Shell Vapor-Phase HDS)[18]	200	13.1

Strict comparisons are not justified because of varying plant sizes, feedstocks and product objectives. Furthermore the degree to which offsites are included in the Shell investment is not known.

Middle Distillate Treating—The hydrogen treating of this fraction has for its objective the production of premium diesel fuels, furnace oils, kerosines and specialty oils. The quality of these products is enhanced by a reduction in sulfur and carbon residue content and an improvement in burning characteristics, color stability, and resistance to sludging. The following costs have been reported:

TABLE 6—Sulfur Removal and Hydrogen Requirements for Several Feedstocks

Charge Stock	Wt. % S	Product	Wt. % S	Hydrogen Consumption CF/Bbl.	Process
Kuwait S.R. Naphtha...	0.078	Solvent naphthas + cat. ref. feed	0.0011	10–20	Unifining[6]
West Texas Naphtha....	0.15	Solvent naphthas + cat. ref. feed	0.0016	50	Unifining[6]
California Naphtha.....	0.141	Solvent naphthas + cat. ref. feed	0.0022	15	Unifining[6]
Calif. Mixed Thermal & Cat. Heavy Naphthas...	0.52	Motor fuel blend. stock	0.09	120	Unifining[6]
Okla. Cracked Gasoline.	0.12	Cat. ref. feed	0.008	420	Unifining[6]
Calif. Mixed Thermal & S.R. Heavy Naphthas...	1.9	Cat. ref. feed	0.008	435	Unifining[6]
Blend of S.R. & Coker Distillates (460 F EP)....	0.107	Cat. ref. feed & fuel oil	0.0011	90	Unifining[6]
Wyoming S.R. Middle Distillates.....	2.1	Prem. diesel fuel	0.14	140	Unifining[6]
Montana S.R. Middle Distillates.....	0.18	Stove Oil	0.010	25	Unifining[6]
Cat Cracked Cycle Oil...	1.15	Prem. kerosine, cat cracking feed, stove oils, diesel fuels, etc.	0.18	190	Unifining[6]
Vis-breaker Distillate...	0.45		0.02	330	Unifining[6]
Santa Maria Coker Dist.	3.9	Cat cracking feed	0.05	800	Unifining[6]
Heavy Vacuum Gas Oil..	1.94	Cat cracking feed	0.39	170	Unifining[6]
Cat Cracked Cycle Oil...	1.37	Cat cracking feed	0.26	150	Unifining[6]
Midl. East S.R. Gas Oil.	1.3	Prem. diesel fuel	0.20	154	Shell Trickle[14]
Midl. E. Light Cat Cracked Cycle Oil.....	2.9	Prem. diesel fuel	0.44	400	Shell Trickle[14]
Cat Cracked Naphtha, LA Basin Crude.....	0.28	Aviation base stock	0.003	500	Shell Vapor-Phase HDS[18]
Cat Cracked Naphtha, LA Basin Crude.....	0.50	Motor Fuel	0.20	110–175	Shell Vapor-Phase HDS[18]
Thermally Cracked Naphtha, LA Basin Crude.....	1.15	Motor Fuel	0.40	200–250	Shell Vapor-Phase HDS[18]
Light S.R. intermediates, W. Texas Crude....	0.45	Mineral spirits kerosine	0.10	65	Shell Vapor-Phase HDS[18]

Charge Stock	Plant Size BPSD	Plant Cost $/BPSD	Op. Cost ¢/Bbl.
S.R. Distillate (400-650 F)	5,000 (Unifining)[6]	85	7.4
Diesel Fuel	10,000 (Hydrofining)[11]	110	.....
Middle East S.R. Gas Oil	10,000 (Shell Trickle)[14]	93	11.4
Middle East Light Cat. Cracked Cycle Oil	10,000 (Shell Trickle)[14]	130	15.5
S.R. Gas Oil	10,000 (Autofining)[8]	160	16.5

Again it is difficult to compare these figures in the absence of knowledge of the extent of desulfurization effected.

In comparing SO_2 extraction and Hydrofining for diesel fuel desulfurization, the investment for the former was almost 50 percent higher. A considerable amount of potential diesel fuel was degraded to fuel oil by the extraction process. The over-all economics favored Hydrofining.[11]

Likewise, a strict comparison of the desulfurization of diesel fuel by catalytic hydrogen treating and by furfural extraction shows a distinct advantage to the former:[32]

	Catalytic	Furfural Extraction
Investment, $/bpsd	178	360
Manufacturing cost, ¢/bbl. feed.....	11.4	28.8

In this case the hydrogen treating is less expensive because of the availability of cheap hydrogen. Moreover, in the case of furfural extraction, a considerably lower yield of low-sulfur product is obtained.

Cat Cracking Charge Stock Treating—Many advantages have been enumerated for hydrogen treating of cat cracking charge stocks over those for the treating of cat cracking products. Technically, pretreatment of cat cracking charge stock improves resultant cracking product distributions and yields. It also removes cracking catalyst poisons such as sulfur, nitrogen and metals.

An economic comparison[33] has been made for the substitution of 25,000 bpsd of high-sulfur crude oil for a like amount of low-sulfur crude oil. With an added investment of $8 million over a refinery with no coking, coking and product Hydrofining may be installed. The return on this incremental investment would be 40 percent before income taxes. If the incremental investment is increased to $10.3 million, coking and Hydrofining of catalytic cracking charge stock could be installed. The 52 percent return on this incremental investment shows that fluid coking and treating of cat cracking charge stock is an economical method of processing a high sulfur crude oil in a low-sulfur refinery.

Lube Stock Treating—The capital investment of a lubricating oil Hydrofining plant was in the neighborhood of $200 to $300 per bpsd which is lower than conventional finishing processes. By-product hydrogen is assumed to be available to permit this low investment. For a 2000 bpsd unit, operating costs would be in the order of 30-40 cents per barrel with hydrogen charged at fuel value.[8]

The hydrogen treating process avoids disposal problems, conserves refined oil, and permits a lower degree of extraction. More stable turbine and transformer oils are also made by this process.

Crude and Residual Oil Treating—The Gulf HDS Process has been employed for upgrading the quality of crude oils and residual stocks.[26] This moderate pressure process converts heavy residual fractions to lower boiling distillate products while simultaneously effecting a substantial degree of desulfurization. Hydrogen consumption for treating a Kuwait reduced crude varied between 650 and 1140 CF per barrel of charge depending upon severity of treatment. Bottoms yield was reduced from 47.4 percent to 4.1 percent by using the greater quantity of hydrogen.

Costs for treating 25,000 bpsd of West Texas crude are reported. An investment of $500 per bpsd and direct operating costs of 25 cents per barrel of crude are required. These costs include complete facilities for hydrogen manufacture.

Compare these figures with the hydrogen treating of a blend of 71 percent of heavy vacuum bottoms from Kuwait crude and 29 percent of high-sulfur light catalytic cycle oil. The investment would be $800 per bpsd and direct operating costs of 75 cents per barrel.

Widespread adoption of this admittedly high cost process for treating crude oils and residual stocks depends economically upon a number of factors:

1. The possibility of lower prices for No. 6 fuel oil.
2. The availability of by-product hydrogen.
3. The rising sulfur content of available crude oils.

While the time schedule for commercialization of hydrogen processing of these stocks will obviously be several years behind that of processing middle distillate stocks, crude oils and residuals will be important charge stocks to hydrogen treating processes within ten years.

Future Trends

Catalytic hydrogen treating, though it owes its growth to catalytic reforming, may actually outstrip the capacity of the latter to supply its growing demands for hydrogen. Even the expected tripling of today's half billion cubic feet of hydrogen per day from catalytic reformers to 1.5 billion by 1965 may not be sufficient for all hydrogen treating contemplated. This is especially true if severe hydrogenation of residuals is called for, a development which may cause refiners to turn to lower grade sources of hydrogen to augment reformer by-product material.

This growth will be a reflection of trends already discussed—the octane race; increased demand for all petroleum products, especially diesel and jet fuels; the necessity to refine poorer crudes and minimize wastage of all crudes; municipal ordinances to control air pollution. The last may standardize such requirements as proposed for New York City, for example, one requiring industrial fuel oil to have a maximum sulfur content of 1.0 percent.

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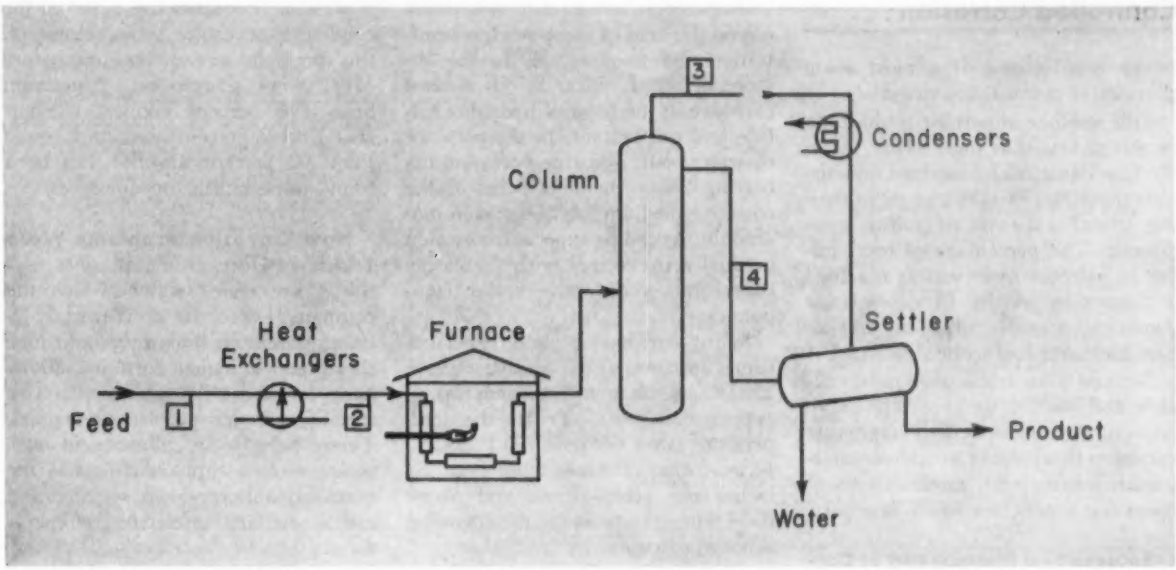

FIGURE 1—Injection points for neutralizing agents.

Controlled Corrosion Cuts Costs

Here's how one company has blazed a new trail in processing high sulfur crudes by avoiding costly alloys and applying suitable neutralization systems.

W. A. Derungs
N. V. DeBataafsche Petroleum Maatschappij
The Hague, Holland

SINCE THE END of World War II new types of crude oil originating from the Middle East are being processed in increasing quantities. These crude oils contain, besides normal contamination by salt water, a high percentage of sulfur.

When the N. V. De Bataafsche Petroleum Maatschappij, The Hague, of the Royal Dutch/Shell Group made new designs for processing these Middle East crude oils, account was taken of the fact that, during distilling, severe corrosion would be caused by hydrochloric acid and sulfur compounds derived from these crudes unless special measures were taken. Because corrosion-resistant alloys were very difficult to obtain at that time, other ways had to be found to meet the problem.

It has been proved that application of unalloyed steel is possible to a greater extent by modifying the operating conditions, especially by restricting the maximum operating temperature and making use of an adequate neutralization system. Injection of a caustic-soda solution of 3 percent by weight mixed with cold crude oil and introduced as such in the feed line between heat exchangers and furnace, combined with injection of a 3-percent aqueous ammonia solution in the overhead line, proved to be efficient and economical.

The Problems—Before World War II a great part of Europe's need for oil products was met by supplies from the United States and Venezuela. After the war new sources of crude oil had to be opened up to meet Europe's ever-increasing demands. Supplies from the Western Hemisphere, which had not in any case been adequate, were required to satisfy the greatly increased domestic consumption in that area. Fortunately, at that time enormous oil fields were discovered in the Middle East and this made it possible to fill the gap between Europe's supply and demand.

The finding of new sources of crude oil, however, was only one of Europe's problems in connection with providing its market with the necessary oil products. Its other, not less urgent, problem was to acquire efficient refining equipment within a suitable time. The capacity of Europe's refineries, being even below prewar level, was obviously far too small. Besides re-equipping wholly or partly destroyed existing refineries, new and larger ones had to be erected, and this

under conditions of a most acute shortage of construction materials.

Still another important problem to be solved was that most MEC (Middle East crude oils) contained undesirable quantities of salts and more than the usual amount of sulfur compounds. The percentage of total sulfur in extreme cases was as much as 7 percent by weight. In view of this condition, special corrosion prevention measures had to be developed.

Because alloy steels were not available and would be too expensive anyway, it was decided to counteract corrosion by applying suitable neutralization systems with modifications of operating conditions when necessary.

Sources and Phenomena of Corrosion—When making the design, three principal factors were faced, each of which could separately give rise to intolerable corrosion.

1. Aqueous Salt Solutions Present in the MEC—The salt and water contents of the crude oils delivered to refineries are kept as low as practically possible. If necessary, desalting and dehydration are used. However, they may still contain a certain amount of aqueous solutions of calcium chloride and magnesium chloride. During the distillation process both salt solutions, especially the magnesium chloride, readily hydrolyse at temperatures above 250 F. As a result, hydrochloric acid forms. The latter, when condensed with water, is very corrosive to nearly all common metals and alloys. Sodium chloride, also usually present, is stable but may cause deposits in the furnace tubes.

2. Sulfur Compounds Present in the MEC—Whereas total quantities of 2 to 3 percent by weight of sulfur in MEC are quite usual, percentages of up to 7 percent by weight are possible. Hydrochloric acid, in combination with water, is most corrosive below dew point, but hydrogen sulfide becomes most active at higher temperatures and without the necessity for water.

The problem of sulfur corrosion is a complicated one and not yet perfectly understood. Besides the problem of corrosion the action of sulfur also involves the hazards of poisoning and fire. Hydrogen sulfide is extremely toxic and ferrous sulfide may ignite spontaneously when exposed to air.

The corrosivity of sulfur is dependent on the kind of compound, concentration and temperature. In the absence of water, sulfur in oils is most corrosive in the form of hydrogen sulfide and mercaptans. In the presence of water, sulfur-dioxide corrosion occurring below the dew point of the corrosive medium has to be taken into account. As can be expected, corrosion gradually increases with increasing concentration of active sulfur compounds.

Sulfur corrosion on mild steel becomes apparent at temperatures above 390 F. but is not disturbing up to approximately 625 F. In the temperature range between 705 F. to 795 F., corrosion rates are more than .39 inches per year. Below and above these temperature limits, the corrosion is not as severe.

3. Cooling Water for Condensers and Coolers—Owing to a lack of fresh water, most of our refineries have to use brackish or sea water as a cooling medium for condensers and coolers. Since mild steel corrodes approximately .04 to .08 ipy in brackish water and more than .08 ipy in sea water, it is not a very attractive material for condenser or cooler tubes. However, this problem already existed before MEC were processed. Aluminum brass (76 percent copper, 22 percent zinc, 2 percent aluminum, more than .02 percent arsenic) has been found to be satisfactory for tubes.

How Corrosion Problems Were Tackled—Disregarding possible corrosion by cooling water—which the company hoped to counteract by using aluminum brass tubes and tube sheets and a higher corrosion allowance for the mild steel shells—two specific corrosion problems remained. These were hydrochloric acid corrosion at low temperatures in the overhead and rundown systems, and sulfur corrosion at elevated temperatures.

Later evidence was found that a combination of hydrochloric acid and hydrogen sulfide causes corrosion to become worse than in the case when either one of the two components is present separately.

Being aware of the two different corrosion problems, the company concluded that, with regard to hydrochloric-acid corrosion, a suitable neutralization system had to be developed; as far as sulfur corrosion was concerned, it was considered quite adequate to restrict the maximum operating temperature. Limitation of temperature, of course, would apply to crude-oil distilling plants, but hardly to high-vacuum distilling plants.

Possible Neutralization Systems—The requirements which a neutralization system must fulfill are as follows:

1. It must effectively prevent corrosion.
2. It must be economical.
3. It must be simple and reliable from an operating point of view.
4. It must be sensitive and adaptable to any fluctuations in the quantity of acid developed during the distilling process.
5. It must not have an adverse effect on the properties of the distillation products (e.g., by depositing unallowable high quantities of salts in the bottom product or by dissolving undesirable agents in the distillates).
6. It must not disturb the distilling process (e.g., by clogging part of the equipment).
7. The neutralized products must be stable and not cause corrosion themselves.

Meet the Author

W. A. DERUNGS joined N. V. De Baatafsche Petroleum Maatschappij at The Hague in 1947, after some eight years of engineering experience in Switzerland. He now serves the company as an advisor on materials and corrosion problems. In this capacity, he has visited all the European refineries of the Royal Dutch/Shell Group to study materials and corrosion problems at the site. And in 1953 he worked as a corrosion engineer at the Curaceo Petroleum Industrie Maatschappij refinery in the West Indies. Derungs is a chemistry graduate of the Swiss Federal Institute of Technology at Zuerich.

The following methods were considered to reduce hydrochloric-acid corrosion:

1. Keeping the quantity of water and hydrolysable salts in the feed as low as practically possible.

2. Neutralization of still-liberated acid at the spot where it is developed, i.e., in the heating-up system.

3. Neutralization of still-liberated acid before condensation in the overhead and rundown system.

4. Combination of the foregoing methods.

With regard to the amount of water and hydrolysable salts present in the feed, it would obviously be a most attractive plan, from a corrosion point of view, to have these components completely removed. This is not practical, however, for several reasons. Usually a water content of approximately 0.1 percent by weight and a salt content of approximately 0.01 percent by weight must be taken into account. Experience has shown that, as a consequence, an average of 11 to 12 ppm of hydrochloric acid (based on crude-oil intake) is developed in MEC plants during distilling process.

Results of Neutralization Tests—Neutralization tests were started with caustic soda and/or ammonia of various concentrations, these agents being most readily available at a reasonable price. Later, other neutralizing agents, buffer solutions, and organic inhibitors were included in the tests. So far these media have shown no advantage over the combined application of caustic soda and ammonia. Therefore, in the following discussion only the latter two neutralizing agents will be considered.

Aqueous caustic-soda solution was tried in concentrations between 1½ to 20 percent by weight. It appeared that concentrations at the upper limit were less effective, while concentrations at the very low limit formed emulsions. Concentrations of 2 to 3 percent proved to be most effective and are now commonly in use.

Ammonia was applied in gaseous form and as aqueous solution from 2 to 30 percent by weight. In this case, too, solutions of 2 to 3 percent proved to be most effective, more so since these low-concentrated aqueous solutions can easily be proportioned by means of pumps.

The different locations where the neutralizing agents had been injected are indicated in Figure 1. The test

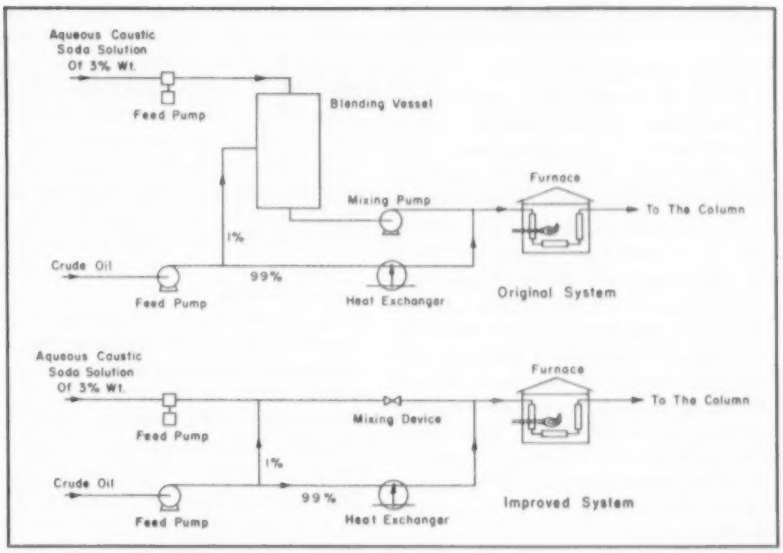

FIGURE 2—Injection of caustic soda at Point 2.

results can be summarized as follows:

1. *Injection of ammonia at point 1 or 2:* Injection of ammonia into the feed results in the formation of salt deposits (NH_4Cl) at the top of the column and in the condensers. On several occasions pitting has been observed underneath these salt deposits. This method was rejected.

2. *Injection of caustic soda at point 1 or 2:* Neither introduction through an injector nor through a spraying nozzle gives a homogeneous mixture of the caustic-soda solution with the crude oil, so that large quantities of caustic soda are required to be effective. The result is fouling and clogging by salt deposits (NaCl) near the injection points. Since the heat exchangers are particularly sensitive to fouling, injection of neutralizing agent at point 1 was abandoned. This method was rejected.

3. *Injection of a hot mixture of caustic-soda solution and crude oil at point 2:* Preparation of the hot mixture is cumbersome and may give rise, at temperatures above 230 F., to stress corrosion. This method was rejected.

4. *Injection of a cold mixture of a caustic-soda solution with crude oil at point 2:* By using up to 50 percent in excess of either a 20-percent or 3 percent caustic-soda solution, 90 percent or 98 to 99 percent, respectively, of the hydrochloric acid developed during distillation is neutralized. A greater excess of caustic-soda solution does not give any improvement. Apart from the fact that neutralization is not yet complete, response to fluctuations of the acid content in the stream is too slow. This method looks promising, but is not yet foolproof.

5. *Injection of ammonia or caustic-soda solution at point 3 or 4:* Injection of neutralizing agents into the overhead or rundown system does not give sufficient protection and—if the agents are needed in large quantities—will cause formation of salt deposits with possible corrosion in the form of pitting. This method may be useful to render small quantities of acid, existing in the overhead system, harmless.

6. *Simultaneous injection of a cold mixture of caustic-soda solution and crude oil at point 2 and ammonia at point 3:* This method is a logical combination of methods 4 and 5. An aqueous solution of caustic soda of 3 percent by weight is mixed with 1 percent by weight of the crude oil which is taken off behind the feed pump and injected into the feed stream at point 2. The quantity of hydrochloric acid which may be liberated during distillation of a certain crude oil is determined by a laboratory batch-distillation test, on the basis of which the necessary amount of caustic soda is calculated, using an excess of approximately 50 percent.

Mixing of the caustic-soda solution with a small amount of cold crude oil is necessary to prevent flashing of the caustic-soda solution and thus clogging of the feed line. Originally this

mixing was carried out by dropwise feeding of a measured quantity of caustic-soda solution from a central caustic-soda supply system into a vessel to which 1 percent of the crude-oil feed stream was continuously pumped.

The combined product was drawn off by a centrifugal pump in which it was mixed and thereafter injected at point 2. Later this system was improved by proportioning the necessary amount of caustic-soda solution with the split stream of the crude oil and blending them by means of a mixing device, e.g., a globe valve, after which the mixture was injected at point 2 as in the original system. Both systems of caustic-soda supply are illustrated in Figure 2.

In this way the main part of hydrochloric acid, i.e., 98 to 99 percent, which is developed during distilling can be neutralized together with small quantities of hydrogen sulfide. The remaining potential acids consist chiefly of hydrogen sulfide plus some hydrochloric acid, which exist in vapor phase in the overhead system. These vapors, when condensed with water, are corrosive; they are best rendered harmless by neutralizing them with gaseous ammonia (obtained by flashing of an aqueous solution) before condensation has taken place. The ammonia is injected as an aqueous solution of 3 percent by weight in order to facilitate proportioning by a pump. Proportioning is controlled by means of a pH recorder (connected to a pH meter fitted with glass electrodes) which measures the aqueous condensate drawn off from a settling vessel behind the condensers. The pH value of the aqueous condensate should be controlled within the range of 7 to 8. By no means should the value of 8.5 be exceeded, otherwise the parts of the condensing equipment which are made of copper alloys will be dissolved. The aqueous ammonia solution, when injected at point 3, is flashed, leaving the gaseous ammonia to react with the vaporized potential acids.

Restriction of the Operating Temperature—Based on available data, a maximum operating temperature of 570 F. could be given as a safe limit below which sulfur corrosion could be considered to remain low. However, when the projects were undertaken, the foregoing figure was raised to 630 F. The argument was to wait and see, and to line or replace the most critical parts by more suitable alloys when it should prove to be necessary.

Practical Experience—

Crude-Oil Distilling Plants—The neutralization system as outlined in the foregoing summary of test results, part 6, has been in use in several refineries for at least 6 years. The practical experience thus gained is best illustrated by the following paragraphs, obtained from the MEC standard distilling plant which has been in operation the longest.

Corrosion of Vessels—All vessels are made of mild steel. Significant corrosion is experienced only in the lower part of the secondary tower working under vacuum. Depending on the operating temperature, the following corrosion rates were found:

At 430 F.: approximately .015 ipy.

At 570 F. to 610 F.: approximately .05 ipy.

In view of the more severe corrosion the lower part of the secondary tower has been lined for temperatures above 570 F. with AISI 405 (13 percent chromium steel). Internals of cast iron are not corroded.

Corrosion of Furnace Tubes—The average corrosion rate for all crude oil distillation unit furnace tubes was .03 inches per year. The maximum rate was .113 inches per year. All roof and side wall tubes in the feed heater furnace coil of the secondary column were replaced after 39 months with 5-chrome, ½-moly tubes, thus reducing the above average value to approximately half.

Corrosion of Condensers—The shells which are made of .39 inch-thick mild steel corroded approximately .08 to .10 inches in four years. The aluminum brass condenser tubes with a wall thickness of .058 inches had, at the beginning, a lifetime of about two years. However, this figure has been and still is subject to improvement, depending on improvement of operating conditions and construction details.

Vacuum-Distilling Plant—As an indication of the corrosion rates to be found in a vacuum-distilling plant, the following figures obtained from test strips and inspection data are given:

Corrosion of furnace tubes—outlet temperature 752 F. to 761 F.:

Mild steel: .08 to .10 inches per year 5-chrome, ½-molybdenum steel: .0019 to .0023 inches per year.

Corrosion of vacuum tower, upper part—temperature approximately 717 F.:

Mild steel: .020 to .035 inches per year 5-chrome, ½-molybdenum steel: .012 to .16 inches per year. AISI 405 stainless steel: .0016 inches per year.

Corrosion of vacuum tower, bottom part—temperature approximately 744 F. to 752 F.:

Mild steel: .06 to .09 inches per year 5-chrome, ½-molybdenum steel: .0046 to .0050 inches per year 9-chrome, 1-molybdenum steel: .0011 inches per year.

Construction Materials—Recommended construction materials for all important components of distillation units handling Middle East or similar crude oils are presented in Table 1.

Original presentation was before the API Division of Refining meeting, May 14, 1956, Montreal. ##

TABLE 1—Recommended Material

Equipment	Below 570 F	Above 570 F	Below 625 F	Above 625 F	625 F to 660 F	Above 660 F
Furnace tubes Return bends Transfer lines	.....	.....	Carbon steel	5% chrome alloy	.....	.....
Important vessels ex., fractionating columns	Carbon steel	Carbon steel, lined with A151 40.5	.....	.....	.....	.....
Less important vessels, ex., accumulator tanks, heat exchangers	.....	.....	Carbon steel	.....	Carbon steel with ⅛" corr. allow., or lined with AISI 405	Carbon Steel, lined with AIST 40.5
Pumps and valves (All parts exposed to corrosive media)	Carbon steel	At least 5% chrome alloy	.....	.....	.....	.....
Process lines	.....	.....	Carbon steel	.....	Carbon steel with ⅛" corr. allow.	At least 5% chrome alloy
Condensers	All Temperatures					
	Shell—Carbon steel Tubes—Aluminum brass according to BS 1464 (similar to ASTM B 111 aluminum brass, type B) Tube Plates—Aluminum bronze according to ASTM B 171, alloy D or E					

How to Instrument a Heater

Here is a guide to proper instrumentation that takes all variables into account and tells when and where to use automatic control.

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OVER-INSTRUMENTATION of process heaters is no better, sometimes worse, than using no automatic instruments at all. The best system usually combines automatic with manual control. This avoids any tendency for an auxiliary controller to interfere with the proper functioning of a major variable controller.

Tubular process heaters are used in continuous processes to supply a constant quantity of effluent at a temperature and pressure as required by the process. Normally, heating is an intermediate operation where the heater receives the charge from one processing unit and delivers the effluent to another. In most processes the rate of flow, the enthalpy and the temperature of the effluent from the heater determine the operation of the whole process, so that the heater has to compensate for any fluctuations in process variables ahead of the heater.

Symbols for Instruments.

CV	Manual-control calibrated valve.
FdC	Differential-flow controller.
FR	Flow recorder.
FRC	Flow-recorder controller.
HC	Manual-control valve.
HCe	Trip shut-off valve.
PdC	Differential-pressure controller.
PI	Indicating-pressure gage.
PIC	Indicating-pressure controller.
SV	Manual shut-off valve.
TC	Indicating-temperature controller.
TRC	Recording-temperature controller.

Operating Variables of Process Heaters—The principal operating variables of process heaters are the rate of feed, the inlet temperature of the charge, the outlet pressure from and the pressure drop through the heater, and the quantity and quality of fuel required to maintain the outlet temperature. In some processes where the charge is a mixture of products from preceding processing units the quality of the charge may also vary, but this is an exception rather than the rule.

Rate of Feed

The rate of feed is normally the simplest variable to control. If the charge is a liquid which is delivered to the heater at a constant pressure and which flows in a single stream without evaporation or decomposition through the heater, so that with a given flow the pressure drop through the heater is affected only slightly by changes in the outlet temperature, the flow can be controlled by a manually-operated valve, with only an occasional touch-up. However, since the rate of flow is usually one of the recorded variables of operation of the heater, a recording flow controller is normally used even on this type of service.

With a substantially constant pressure drop through the heater the valve of the flow controller can be sized so that at normal flow with the valve half open the pressure drop through the valve is 10 to 15 percent of the pressure drop through the heater.

If the charge passes through the heater in two or more parallel streams, particularly if a change of phase occurs in the heater, the flow to each stream must be controlled automatically. Otherwise, what may have started as a small deviation from normal flow or outlet temperature in one of the streams may end up as a major upset. For example, if a major portion of a narrow boiling-range charge is evaporated in the last few tubes of the coil or if the charge is decomposed at high rates near the outlet of the coil, a small decrease in flow or increase in the outlet temperature of one of the coils may increase appreciably the volume of vapors or gases formed and the pressure drop through this coil.

Without automatic flow control an increase in pressure drop will tend to decrease the flow through the coil, which, with a given rate of firing, will result in an increase in the outlet temperature, additional increase in pressure drop, additional decrease in flow, and so forth until the flow is reduced sufficiently to coke up the stream.

Where the pressure drop through the coil is affected by small changes in outlet temperature the valve of the flow controller is sized for a pressure drop of at least half of the pressure drop through the heater at normal flow, so that the valve will not be forced to a fully-open or to a practically-closed position by the variations in pressure drop through the heater.

Theoretically, in order to obtain the same outlet temperature from each stream in a multi-stream multi-burner heater it should be operated with equal flow through the streams and with burners fired at equal rates. In practice, the closest approach to equal outlet temperatures from the individual streams is often obtained by slightly unbalancing the flows and firing some burners harder than the others. Therefore, in multi-stream heaters, individually set flow controllers are preferable to proportioning interlocks, because they permit adjustment of each stream independently of the others for the best compromise be-

tween rate of flow and burner setting.

If the total rate of flow through the heater must be adjusted frequently to meet process variations ahead or beyond the heater, a manual loading station is normally used to increase or decrease the flows by the same amount simultaneously in all streams by a single adjustment at the station.

The flow control valves must be arranged to remain open in case of failure of instrument air supply so that flow is maintained through the coil at all times.

Pressure

Normally, process heaters discharge directly into a vessel maintained at a constant pressure, so that the vessel acts as the pressure controller on the outlet of the heater. Where the heater outlet is maintained at higher pressure than the vessel receiving the effluent, an automatic pressure controller is used.

If the pressure drop through the heater is greatly affected by variations in the outlet temperature, due to marked changes in the extent of evaporation or decomposition with small changes in the outlet temperature, an intermediate temperature in the coil is used as a secondary sensing element. This acts as an anticipatory load-change correction and adjusts the compensating element of the pressure controller. A decrease or increase in the pressure drop through the heater is anticipated before the full impact of the change in pressure drop is exerted upon the pressure controller.

The valve of the pressure controller is usually arranged for flushing the surfaces of the plug and the seat, particularly if the effluent has a tendency to coke due to decomposition or retrograde condensation. The flushing fluid, some high boiling range liquid produced in the process which will not evaporate completely in the valve, is introduced through the bonnet of the valve. If the effluent must be quenched on the outlet from the heater the quench fluid may be used as the flushing fluid.

Rate of Firing—The most important variable in the operation of process heaters is the rate of firing required to maintain a constant outlet-temperature. The selection of the type of control best suited for a particular heater depends on the type of fuel burnt, the magnitude of fluctuations in the operating variables which must be compensated for by changes in rates of firing and the response of the controlled temperature to variations in the rate of firing.

Figure 1a shows a schematic arrangement of the simplest system for automatic firing, applicable when the heater is fired with gas of a constant calorific value supplied at a constant pressure. The total flow of gas to the burners is controlled by a pressure regulator on the gas header, and the pressure regulator is reset by a temperature controller on the 'controlling' temperature of the effluent.

Depending on the process and the relation between the temperature and the enthalpy of the effluent, the controlling temperature may or may not be the outlet temperature. When most of the heat supplied to the fluid near the coil outlet is used as sensible heat, so that an increase or decrease in the rate of firing is fully reflected in the outlet temperature, the outlet temperature is used as the control point.

If the major portion of the heat supplied near the coil outlet is used as latent heat of evaporation or decomposition, so that a relatively large change in the rate of firing produces only a small change in the outlet temperature, the controlling temperature is usually moved to some point ahead of the outlet. Here an appreciable portion of the heat is still utilized as sensible heat and the temperature, while it bears a definite relation to the outlet temperature, responds much faster to changes in firing rates than the outlet temperature.

Figure 1b is a schematic arrangement of gas-firing control where a flow controller is reset by the temperature controller. This system is used where the supply pressure to the gas header is not maintained constant, or where fluctuations in the inlet temperature of the charge or in the quality of charge call for wide variations in firing rates, which may cause a wide fluctuation in the gas pressure on the burner. A pressure controller would have a tendency to hunt to maintain the desired temperature.

In some plants the fuel used for gas firing is a mixture of tail gases from different processes and purchased natural gas. If the tail gases are not produced at constant rates or if the composition of the tail gases fluctuates widely, the calorific value of the mixed fuel-gas will vary. The temperature controller will be kept off balance by changes in the quality of the fuel. Under these conditions the temperature controller may have to be augmented by a secondary sensing element to anticipate the load change and adjust the compensating element of the temperature controller to compensate for variations in the fuel.

Generally, the calorific value of a mixture of hydrocarbons and hydrogen is reflected in its specific gravity, so that changes in gravity can be used to reset the controller. With some gas

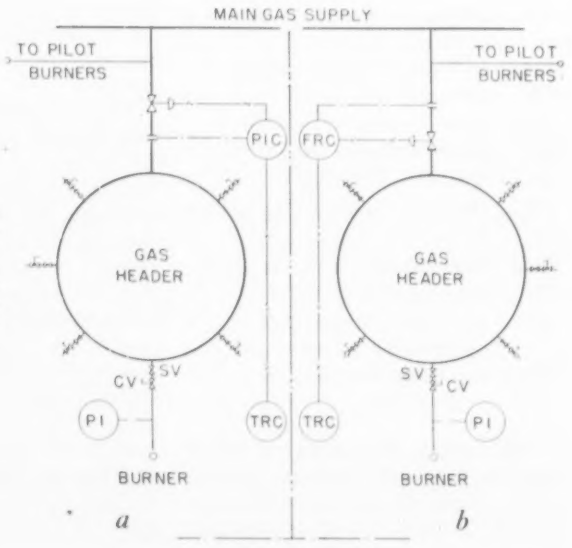

FIGURE 1—Alternate methods of automatic gas firing. *(a)* Gas at constant pressure and calorific value. *(b)* Flow controller reset by temperature controller.

mixtures a change in proportions of certain components may materially change the calorific value without appreciably changing the gravity. With these mixtures a calorimeter may be required for resetting the compensating element of the temperature controller.

Types of Process Heaters—Structurally, process heaters can be divided into two groups:

1. Heaters with a large 'cold fraction' in which the major portion of the furnace setting is covered with tube banks. Normally, the settings of these heaters are laid up with insulating refractories and, if auxiliary bare refractories are used to increase re-radiation in these heaters, they are made of thin alloy plate. Generally the heaters of this group have a low 'static' heat capacity which must be overcome to increase or lower the operating temperatures.

2. Heaters with a small 'cold fraction' where the area of the bare refractories is equal to or greater than the area of the setting covered by tube banks. The setting of the heaters is usually laid up with firebrick. Also, some heaters in this group have bridge walls, separating walls or target walls containing large quantities of firebrick, so that the static heat capacity of the refractories in these heaters is much higher than in the heaters of the first group.

The bare refractories of process heaters re-radiate to the tube banks, and the proportion of the total radiant heat thus supplied to the tube banks is a direct function of the refractory area and of the difference of the fourth powers of 'equilibrium temperature' of the refractories and of the metal temperature of the tube banks. The equilibrium temperature is the steady state temperature of the refractories at which they re-radiate to the tubes all the heat they absorb from the flames.

In heaters with a large cold fraction and refractories of low heat capacity, a change of firing rates will be reflected almost immediately in the controlled temperature so that the controller can be set for a minimum lag between changes in temperature and rates of firing.

In heaters with a small cold fraction and refractories of high heat capacity the refractories will retard the response of the controlled temperature to changes in firing rates, and will increase the tendency of the controller to overshoot the set point. For example, if the controlled temperature is below the set point and the controller calls for higher rates of firing, only part of the additional heat generated by the higher firing rates will be applied to raise the controlled temperature. This is because some of the additional heat will be used up to increase the equilibrium temperature of the refractories.

Until the refractories are brought to the new equilibrium temperature they will tend to 'cool' the coil, and call for higher rates than would be required without the cooling, until the set point on the controller has been reached and the controller stops increasing the firing rates. Because of the higher firing rates the controller will tend to exceed the normal over-correction of the controlled temperature and may overshoot considerably the equilibrium temperature of the refractories.

In order to bring the temperature down to the set point the controller will then start reducing the rates of firing. At this point the refractories, in coming down to the proper equilibrium temperature, will begin to supply heat to the coil and the controller will have to decrease the rate of firing more than would be required without the refractories acting as a source of additional heat. The controlled temperature will be again over-corrected and so on, so that the controller will keep on cycling between over-correction on both sides of the set point.

To reduce cycling to a minimum the controller must have a 'rate action' added to proportional reset, so that first the final control element is moved farther than would occur normally, and then the controller, in trying to remove the effects of the larger step, counteracts the effect of the lag. With this type of controller the thermal inertia of the bare refractories will help to stabilize the controlled temperature and iron out minor variations in heat requirements or small unintentional changes in rate of firing.

Control With Gas Firing

The automatic temperature controllers shown in Figure 1 operate on the total flow of gas to the burners. Under ideal conditions, that is, with symmetrical connecting piping between the gas header to the burners, a negligible pressure drop through the header and the connecting piping and identical gas ports in the burners, the total flow of gas will be equally distributed between the individual burners. These conditions are seldom obtained in practice.

Where best operation of the heater depends on equal firing of the individual burners the flow of gas to the burners must be equalized by individual manual-regulating valves on each burner, indicated as CV on the diagrams. Valves SV are shutoff valves used primarily to take burners out of service without disturbing the setting on the regulating valves.

On the better made gas burners the gas ports are machined with sufficient accuracy to serve as metering orifices. The flow to the individual burners can be equalized by setting the regulating valves for equal pressure on each burner. With gas burner pressures above 10 pounds per square inch gage at normal capacity the flows, once set, will remain substantially equal through the full range of normal variations in rates of firing.

The automatic control valves on the gas header are placed on a bypass and arranged to close in case of failure of instrument air supply, and are provided with a trip shutoff which must be reset manually before the system can be put back in operation.

Control With Oil Firing—Automatic control of oil firing is more elaborate than gas firing, particularly if more than one heater is supplied with fuel from a common source. The quantity of oil delivered to a burner depends on the pressure drop through the regulating valve of the burner and the viscosity of the oil at the valve. The viscosity, in turn, depends on the temperature to which the oil is preheated. With the heavier residual oils, which are normally used to fire process heaters, a few degrees difference in the preheat temperature of the fuel will materially change the viscosity. Therefore, for satisfactory oil firing, whether automatic or manual, the fuel oil supply to the heater must be automatically maintained at constant pressure and temperature.

Figure 2 shows a schematic arrangement of a 'parallel-loop' fuel-oil circulating system arranged so that a variation in the rate of firing of one heater does not affect the firing rates of the other heater on the system. The

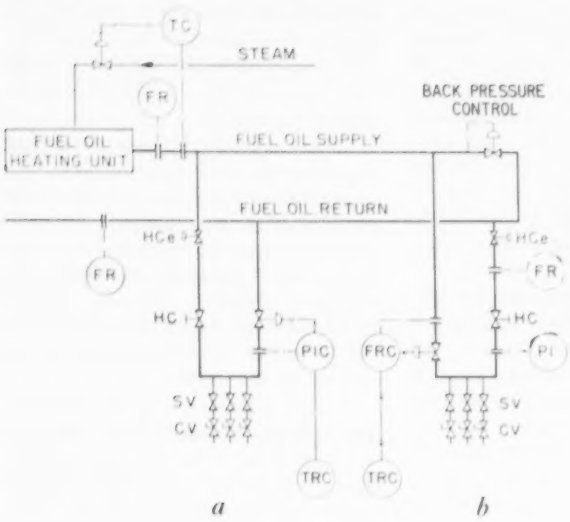

FIGURE 2—Parallel-loop fuel-oil circulating system. *(a)* Pressure regulator reset by temperature controller. *(b)* Flow controller reset by temperature controller.

parallel loop system while somewhat more complicated than a series system permits fully independent control of rate of flow and pressure through the individual loops. With a parallel arrangement any of the loops can be taken out of service without affecting the setting on the other heaters.

With heavy, viscous, and occasionally dirty, fuels used in oil refineries, it is often necessary to flush one of the loops by greatly increasing the flow and the pressure drop through the loop or to isolate the loop for steaming it out. This can be done without affecting the other heaters only with the parallel loop system, and this alone would justify the slight extra cost of the system.

While two heaters are shown connected to the system the arrangement applies to any number of heaters in parallel. The supply header of the system is maintained at a constant pressure of 80 to 150 lb. psig for steam atomizing burners and 150 to 300 lb psig for mechanical atomizing burners. The pressure on the return header is just sufficient to overcome the pressure drop through the header. The flow recorder on the supply header is set for a flow through the system three to four times the amount consumed by the heaters.

The flow recorder on the return header is optional and is used only to determine the fuel consumption of the battery of heaters on it. The flow through the return header is just sufficient to compensate for the radiation losses through the header with only a few degrees in temperature drop, so that a substantially constant oil viscosity is maintained through the system.

Each heater has a separate circulating loop connected to the supply header on one end and to the return header on the other. The circulation through each loop is three to four times the amount of fuel consumed by the heater.

Figure 2a shows an arrangement for automatic oil-firing using a pressure regulator on the outlet of the loop, which is reset by the temperature controller. The total flow of fuel oil through the loop is set manually by a valve on the inlet and the pressure regulator adjusted for the desired loop pressure. When the controlled temperature deviates from the set point the temperature controller increases or decreases the pressure on the loop which, in turn, increases or decreases the flow of oil to the burner.

Figure 2b shows the use of a flow controller reset by a temperature controller for automatic oil-firing. The flow controller is set for an average flow through the loop at normal rates of firing and the back pressure on the loop is adjusted manually by a valve on the outlet. The flow recorder on the outlet of the loop is optional and is required only if the fuel consumption of the individual heater is to be measured.

The flow controller is used indirectly as a pressure controller which increases or decreases the pressure on the loop by changing the flow and the pressure drop through the loop. However, since the main purpose of increasing the pressure on the loop is to increase the flow of fuel to the burners, and since it requires approximately a 20 percent increase in pressure to obtain a 10 percent increase in flow, the response of the flow controller to the demands of the temperature controller is more direct and quicker than that of the pressure controller.

Another advantage of the scheme shown in Figure 2b is that it permits a close control of the ratio of atomizing steam to oil, with only a small addition in instrumentation and expense.

Steam-Oil Interlocks

For proper operation of steam-atomizing oil burners the oil must be fully atomized and the degree of atomization maintained the same for all rates of firing. Insufficient steam will produce "fire flies" and long smoky flames even with large amounts of excess air. Too much steam may blow out the fires. Therefore, to maintain the proper quality of flames with automatic oil-firing the quantity of atomizing steam as well as of the oil supplied to the burners must also be automatically controlled.

Figure 3 shows a schematic arrangement of an interlock for roughly proportioning the atomizing steam and fuel by maintaining the pressure on the steam header higher than the pressure on the oil loop by a fixed amount, usually 10 to 30 psig. This arrangement, used in conjunction with the scheme shown in Figure 2a, is satisfactory for small variations in the controlled temperature and a relatively broad tolerance in the luminosity of the flames.

Figure 4 shows a scheme for maintaining the quantity of atomizing steam in exact proportion to the amount of fuel-oil burnt, by interlocking a flow controller on the steam header with a proportional flow controller, actuated by the amount of fuel oil burnt as obtained from the difference in flow through the flow controller on the inlet to the loop and the flow meter on the outlet from the loop.

The interlock as shown in Figure 4, though more expensive and complicated than that in Figure 3, is prefer-

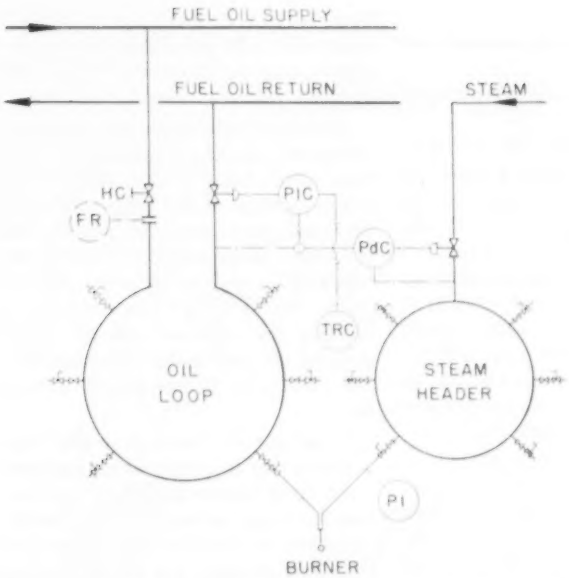

FIGURE 3—Interlock arrangement between fuel-oil pressure and atomizing steam pressure.

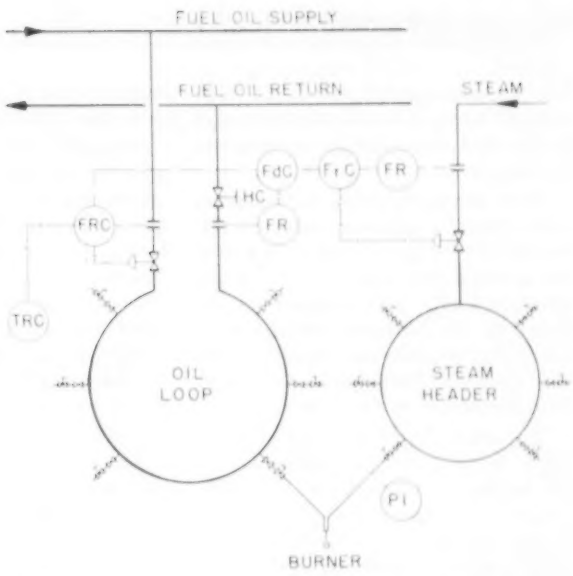

FIGURE 4—Interlock for proportioning atomizing steam to fuel.

able where the luminosity and the length of the oil flames affect the heat distribution in the heater, or where the heater is fired with a minimum amount of excess air.

With fuel-oil firing it is even more important to be able to adjust the individual burners for equal firing rates and the same quality of fires. The tendency at present is to use a calibrated metering type of valve to control the distribution of fuel oil to the individual burners and to adjust the flow of atomizing steam to the burner, so as to obtain substantially equal pressures on the pressure gages on the downstream of the steam-regulating valve. The pressure gages are only a guide and manual touching up may be required to have the rate of firing and quality of flame the same on all burners.

Fuel oils of a given grade have substantially the same calorific value throughout the range of normal variation in composition and gravity. Therefore, with oil firing, no anticipatory control is required to compensate for differences in quality of the fuel. However, just as with gas firing, anticipatory resets will be required to compensate for wide variations in inlet temperature or rate of feed, and a rate-action variable adjustment of firing rates will be required to compensate for high heat capacity of the refractories.

In case of failure of instrument air the control valves and the trip valves on the fuel-oil loop are arranged to shut off the flow of fuel to the burners, and the valves controlling the flow of steam are arranged to open to keep the burner nozzles cool.

The arrangement in Figures 1 to 4 show automatic firing control applied to the total fuel supply to the burners. When a heater is fired partly with oil and partly with gas it is quite common to fire the oil burners manually at a constant rate and to use automatic control on the gas burners. Sometimes, even when a single fuel is used, a fixed portion of the total fuel (and atomizing steam, with steam-atomizing burners) is supplied through a bypass on the controller, and the remainder—usually not less than 30 percent of the total—is controlled automatically.

The arrangement has the advantage of lower cost, because of smaller control valves required, uninterrupted firing, even though at reduced rates, when the instrument air supply fails, and an "ignorance factor," because it permits some shifting of the ratio of manual to automatic control to correct for improper sizing of the control valves.

The main disadvantage of automatically controlling only a portion of the total heat requirements is that the controller can be easily put out of balance by frequent manipulation of the manually-operated valves on the bypass "to trim" the automatic controls.

Automatic versus Manual Firing—Automatic firing of process tubular heaters is spreading in use because of its many advantages over manual firing. However, automatic firing may have a number of disadvantages if too much faith is placed in the automatic equipment and the heater is not checked by the operator at regular intervals.

One of the disadvantages is that the firing controllers are arranged to change the total flow of gas, or oil and atomizing steam to all burners, with no regard to distribution of the total flow among the individual burners. With a large number of burners the heater may appear to operate properly even if some of the burners are completely out.

Unless the heater is checked at regular intervals, the firing may become so unbalanced as to affect the heat distribution in the heater, the time-temperature relation in the coil, and the over-all results obtained with the process.

Another disadvantage of unattended automatic firing control is that it may obscure a small tube rupture. Without automatic firing, the fire from the rupture will start raising the furnace temperature and the outlet temperature of the fluid, and thus will signal to the operator that something

is amiss. The rupture can then be discovered while it is still small and the heater shut down before any damage is done.

With automatic firing the temperature controller will compensate for the fire by reducing the rate of firing of the burners. The small rupture, if not detected easily, will continue to increase in size owing to weakening of the metal around the rupture, until the tube splits, causing a large fire and serious damage to the heater.

One more disadvantage of automatic firing is the temptation to use the automatic controller to bring the heater to stream conditions so the operator can pay more attention to the other process components of the unit.

Normally, the higher the temperature of the heater the sooner the unit will come on stream. If during the start-up the set point on the temperature controller is advanced in large increments, the controller may demand such high rates of firing that the resultant heat input rates will exceed the permissible maximum, and the furnace temperature will become higher than is considered safe for the structure of the heater.

Safety Interlocks

To protect the heater against overfiring, some heaters are provided with an interlock shown schematically in Figure 5. In this arrangement the temperature controller is over-ridden by a selected furnace temperature. When this temperature is reached, the flow of fuel to the burners is not increased even though the temperature controller calls for it.

Normally, when used for this purpose the override actuates a signal, to advise that it took over, and freezes the valves controlling the flow of the fuel in the position it reached just before the override started functioning. The override can also be used as a short-time safety device with a small rupture to cut down the rate of firing in proportion to the amount of fire, so that a selected furnace temperature is maintained below a certain maximum.

The best method of making sure that an automatically-fired process heater does not get too far out of line is to look into the heater at regular intervals. For this reason, in many plants a separate instrument panel is installed at the heater to indicate or record the pertinent operating variables of the heater, such as controlled temperature, furnace temperature at a number of points, fuel consumption, drafts, etc. The operator then must go to the heater at regular intervals to obtain the readings for the log sheets and also to observe and record the conditions of the fires.

Tube Metal Temperature Measurements—In some processes the combined effects of operating temperatures, pressures and heat-transfer rates make it necessary to operate the heater with tube metal temperatures only slightly below those allowable for the alloy used. If, as the run progresses, deposits are formed inside the tubes, higher tube metal temperatures will be required to maintain the desired outlet temperature at normal feed rates, and the allowable temperatures may be exceeded when the deposits reach a certain thickness.

In heaters where furnace temperatures are in proportional relation with tube metal temperatures, particularly if the location of the hottest tubes in the bank may vary from run to run, a furnace temperature selected by experience is used to limit the rate of firing. When this temperature is reached the operator reduces either the rate of feed or the outlet temperature or both, or the heater is shut down.

If the rate of feed or the outlet temperature can be progressively reduced for a considerable period of time before the heater is shut down, a furnace temperature controller may be used to reset automatically the rate of feed or the outlet temperature by an interlock similar to that shown in Figure 5.

In most cases, the metal temperatures as indicated by skin thermocouples are used to determine when to reduce the rate of firing or shut down the heater. The couples measure the temperature on the exposed face of the tubes expected to have the thickest deposits and therefore the highest metal temperature. Usually more than one tube of a coil is equipped with skin couples and at least one of the tubes has couples at two or three points along its length.

Figure 6 shows a typical arrangement of one of the methods used for installing skin thermocouples. The hot junction of the couple is peened either directly into the outside surface of the tube, as shown in detail C, or into a pad which is strapped or welded to the tube as shown in detail B. If a pad is used, the outside surface of the tube and the inside of the pad are machined to make a good contact. The end of the protection tube is also carefully machined to fit the contour of the tube, and is seal-welded to the tube to protect the hot junction against oxidation.

To eliminate stresses on the seal weld when the tube moves and tends to pull the protection tube with it, the protection tube is rigidly attached to the tube at another point, as indicated in detail A. The opening in the refractory, the closure plate over the opening and the leads from the couple are so arranged that the couple can move freely in the opening.

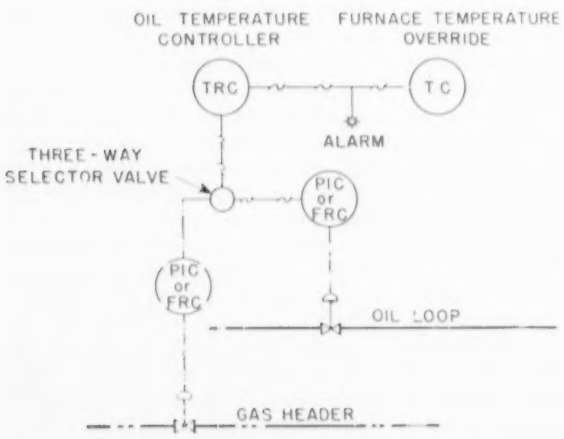

FIGURE 5—Override of oil temperature controller by furnace temperature.

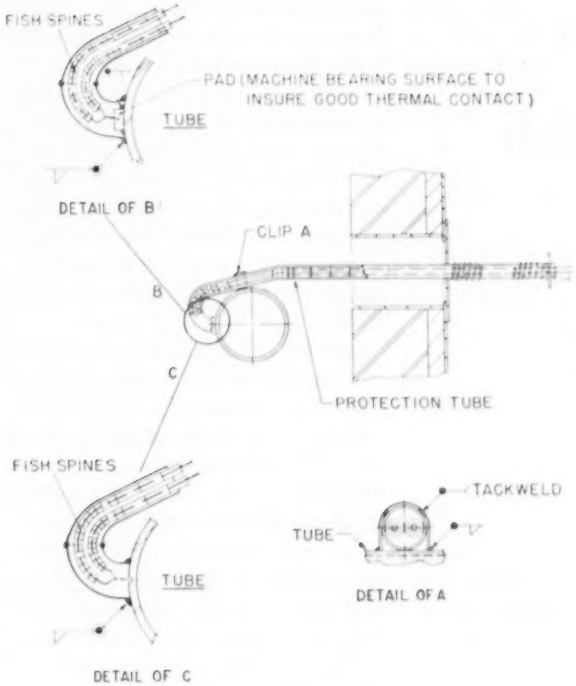

FIGURE 6—Schematic arrangement of tube skin thermocouples.

Skin temperatures, as read, are in most cases only relative because they are affected not only by the tube metal temperature but also by radiation and by convection from the gas streams in contact with the tubes. However, with properly installed thermocouples, a change in metal temperature is reflected almost directly in the skin couple readings so that the readings can be used to establish an empirical maximum permissible metal temperature.

The response of skin couples to changes in furnace temperature is, if anything, advantageous, because the couples will also indicate flame impingement or other causes of local overheating of the tube. Skin couples can be used also to detect and to correct misoperation of individual burners or to adjust the firing rates of a group of burners which affect the particular skin temperature.

A constantly increasing number of process heaters are now being equipped with automatic control of combustion air to keep the excess below 30 to 40 percent. In general, the instrumentation is similar to that used for steam generators except that the preferred set point is the oxygen content in the stack gases. Usually the controls operate a damper on the inlet to the combustion chamber rather than on the stack damper.

With natural draft a common plenum chamber is used to permit control on the inlet. The main reason for not using the stack damper is to avoid obstructing free flow of gases out of the heater. The charging stock of most process heaters are combustible. In case of a tube rupture, or some other serious leak of charging stock into the combustion chamber, a serious fire may occur inside the heater. With a damper on the inlet to the combustion chamber the combustible gases and vapors for the heater can escape through the open stack into the atmosphere above the process area. If the air supply to the heater is shut off by closing the stack damper, these gases and vapors will be forced into the process area through the burner blocks, observation doors and other openings in the heater which may spread the fire to other equipment in the area.

With exhaust draft, particularly if air preheaters are used, the normal instrumentation to control the air supply on the inlet of the heater is augmented by safety interlocks which, in case of a fire in the heater, open a bypass to send the gases directly to the stack and isolate the exhaust fan and the air preheater.

The automatic controls described in this paper are applicable to any process tubular heater but only in exceptional cases will all of them be required on any particular heater.

Better results are often obtained with judicious blending of manual control, with automatic controllers properly tuned to the process requirements and the performance characteristics of the heater, than with full automatic control, particularly when some auxiliary controller tends to interfere with the proper functioning of a controller on a major variable, as is often the case with over-instrumentation.

Reprinted with slight changes in arrangement from a paper originally presented at the Joint Conference on Combustion, Section 3, Industrial Furnaces of The Institution of Mechanical Engineers and The American Society of Mechanical Engineers, June 16, 1955, in Boston. This paper is scheduled for publication by the Institution of Mechanical Engineers in the "Proceedings of the Joint Conference on Combustion, 1955."

Meet the Author

L. A. MEKLER has been engaged in petroleum-refining and related industries more than 35 years, of which about 20 were spent with Universal Oil Products Company. He has been a consultant since 1948. Born in Russia, he was educated in Manchuria, Scotland and at the University of California. Mekler holds more than 80 U. S. and foreign patents covering application of heat to petroleum-refining processes; he has written articles for technical journals both here and abroad, and is a member of numerous professional societies.

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New Yugoslavian Refinery Uses Combination Approach

Thermal combination plant meets gasoline quality needs for Yugoslavian market.

F. Sager
Kellogg International Corporation
London

COMPLETION OF the new refinery at Bosanski Brod, Yugoslavia, has upped gasoline production for the country by 40 percent (from 101,228 tons to 141,228 tons per year). At the same time, value of fuel oil has been increased three times. The new thermal combination plant meets the needs for Yugoslavia's gasoline market (much lower than U. S.—72 regular and 79 premium, F-1).

Process specifications for the plant were furnished by The M. W. Kellogg Company; erection was by Friedrich Uhde (Dortmund, Germany).

It is designed to handle 2600 barrels per stream day of 40 percent Iranian reduced crude and to yield 30.3 percent of gasoline, 2.5 percent LPG (containing 65 percent of the C_3-fraction), 5.2 percent gas and 62.0 percent heavy residue (all percentages are by weight on the reduced crude intake).

Further, 1200 bpsd of heavy virgin naphtha can be reformed yielding 77.0 percent gasoline, 7.9 percent LPG (containing 65 percent of the C_3 fraction), 10.1 percent gas and 5.0 percent heavy residue (all percentages by weight on the heavy naphtha intake).

The combined gasoline fraction with a RVP of 10 pounds is calculated to have a clear octane number (F-2) of at least 67.5 and was in practice over 70.

Any other Middle East Crude, or

Flow Scheme in Detail

Heavy s.r.-naphtha is charged to the naphtha reformer furnace B-1. The effluent of the furnace at 1040 F. and 750 pounds per square inch is simultaneously quenched with recycle gas oil and reduced in pressure before entering the evaporator section of combination tower E-1.

Reduced crude is charged through preheaters C-2, C-3 into the lower suction pan of the combination tower E-1 or directly into the suction off the pan. Combined with a recycle stream it is charged to the visbreaker section of the combination furnace B-2, where the combined stream is heated to 920 F. at an outlet pressure of 250 psi. The furnace effluent is then quenched with recycle gas oil, the pressure is reduced, and the mixture of liquid and vapors passes to the evaporator section of combination tower E-1.

Light gas oil feed, consisting of light visbreaker gas oil and recycle is withdrawn from the upper suction pan and charged to the gas oil section of combination furnace B-2, which it leaves at 1000 F. and 750 psi to be quenched and reduced in pressure before entering the evaporator section of combination tower E-1.

Combination tower E-1 works at 125 psi and consists of three sections. In the lower part, the evaporator section, the three cracking coil effluents are separated into vapor and cracking tar liquid. Cooling and cleaning of this section is accomplished by recirculation of evaporator and vacuum tar. The evaporator vapors are fractionated by means of baffles with gas oil recycle to the upper baffle as temperature control.

In the central section of the tower, the heavy gas oil section, evaporator vapors are fractionated into heavy gas oil bottoms which accumulate on the lower suction pan, the such called visbreaker pan, and are pumped together with the reduced crude charge to the visbreaker coil of the combination furnace B-2. Light vapors rise to the upper section of the tower, the bubble section. Recycle gas oil and light vacuum gas oil entering the upper part of this section help the cleaning-up of the rising vapors. Heavy vacuum gas oil enters the central part of this section.

In the upper part of the tower, the bubble section fractionation of gasoline and light gas oil takes place. The control is effected by an intermediate gas oil reflux stream, by return of rich gas oil from absorber E-5, and by the circulating reflux system on the tower top. Light visbreaker and recycle gas oil collects on the upper suction pan, the such called gas oil plan, from where it is charged to the gas oil coil of the combination furnace B-2. The other stream taken off the gas oil pan has an important role to fulfill. After providing reboiler heat for C-14 at after-fractionator E-4, for C-15 at gasoline stripper E-6 and for C-16 at stabilizer E-7 it is split into two streams. One of them serves as lean oil for absorber E-5 and from there is charged as rich oil to the bubble section of the combination tower E-1. The other stream after providing preheat for the boiler feed water in C-8 and after further cooling in box cooler C-80 is used partly as quench oil to each of the three furnace coil outlets and partly as net reflux for each of the three sections of the combination tower E-1.

Bottoms of combination tower flow by pressure differential into vacuum tower E-2. Steam superheated in combination furnace B-2 is injected at the bottom of the vacuum tower E-2. The vacuum tower bottoms are pumped through exchanger C-3 and box cooler C-81 to storage after a small amount of naphtha from naphtha stripper E-3 has been added for viscosity adjustment.

Vacum tower E-2 has been designed with internal condensation of the flash distillate in two cuts, light and heavy vacuum gas oil, which are separately returned to the central section of the combination tower E-1. From a trap out on the

Yugoslavian crude can be processed with virtually the same results.

These process facilities are provided:

1. Thermal reforming.
2. Recycle visbreaking of the reduced crude charge.
3. Recycle cracking of the light visbreaker gas oil.
4. Vacuum flashing of the combined evaporator bottoms to produce fuel oil, the vacuum flash distillates being returned to the cracking system.
5. Vapor phase refining of the gasoline by means of active clay.
6. Gas recovery system for the production of LPG and caustic washing of same.
7. Stabilization of the combined gasoline followed by caustic and doctor washing, including continuous spent doctor solution regeneration.

The design is based entirely on the combination principle in contrast to the conservative unit layout. Advantages are big savings on direct operating costs, on the costs of off-site facilities and even on process equipment.

Figure 1 shows the simplified flow. Operating conditions given are those called for by design. They vary only slightly with variation of crude.

The plant is fully instrumented and there is a central control room with a graphic panel for the whole plant.

Once the proper operating conditions have been adjusted for a certain type of crude, the plant keeps itself perfectly balanced. Adjusting the proper operating conditions establishes an equilibrium between the make of gas oil in the visbreaker section and the cracking of gas oil in the gas oil section. Although practically all levels are directly controlled by control instruments, it is not possible to do this for the levels in the visbreaker—and gas oil suction pan of the combination tower E-1, because the levels there are primarily the result of cracking severity. It is this process variable which has to be adjusted to the proper degree.

Since severity of cracking is highest in the gas oil coil, the gas oil circuit from the combination tower through the furnace and back deserves primary attention. Coke deposit in the gas oil cracking coil might be a factor limiting the duration of the run. Keeping the gas oil in this circuit clean is therefore of utmost importance.

A unique device in the plant is the recording instrument for gas oil color in the light gas oil circuit. A small sample line was installed in the gas oil recycle line after cooler C-80 and a small stream of gas oil is continuously bled through a photo cell which acts as a transmitter to the recording instrument in the central control room. This recording instrument is graduated from 1 to 3 following the scale for ASTM test D 155-45 T and

bottom tray a slop cut is returned to the bottom of combination tower E-1 as flux medium for the circulating vacuum tar. Condensing duty for the heavy distillate is provided by steam generator C-9 which produces 220 pounds per square inch gage saturated steam and the water cooler C-10 inserted in this cycle.

Gland oil return is combined with the condensing reflux at the top of vacuum tower E-2 and is pumped from the upper suction pan together with the light vacuum distillate to the central section of combination tower E-1.

The gasoline vapors and gas leaving the combination tower E-1 at an overhead temperature of 410 F. pass through one of the two clay towers operated alternatively until removal of deposited polymers from the clay bed is necessary. This is effected by blowing with superheated steam downwards and out to the blow down system. The towers which work under 116 psi pressure are considered to have become ineffective when the temperature rise due to exothermic heat of polymerization no longer occurs. From the standpoint of product quality exhaustion of the clay is first apparent by increase of gum content and only later by off-color.

During normal operation the clay bed is constantly washed with the bottoms from after-fractionator E-4. The polymers and wash-liquid are collected in drum F-2 and from there pumped to the evaporator section of the combination tower E-1 for fractionation and re-cracking. Gas and vapor from the clay towers pass to the after-fractionator E-4, working at 110 psi where a bottom temperature of 475 F. is kept. Vapors are condensed in C-11 and the liquid collected in vessel F-3 from where reflux is returned to top plate in E-4. The net liquid is pumped to gasoline stripper E-6, working at 105 psi 225 F. at the bottom and 110 F. at the top. Overhead vapors combined with vapors from vessel F-3 go to the bottom of asborber E-5.

From the gasoline stripper E-6 the gasoline passes through exchanger C-17 into stabilizer E-7 working at 235 psi, 425 F. at the bottom and 140 F. on the top. Overhead condensate is collected in vessel F-4 from where part is pumped back to stabilizer E-7 as reflux while the balance, the LPG-product, is sent to chemical treatment. Stabilized gasoline after having passed water cooler C-18 and a pressure reducing valve flows to chemical treatment.

This chemical treatment is not shown in Figure 1. Stabilized gasoline is first caustic washed to remove the greatest part of hydrogen sulfide. Doctor treatment follows, and a final water wash concludes the treating procedure. Doctor solution is continuously recirculated through the system which includes a regenerating vessel, where the partially spent solution is heated and blown with air for regeneration. Occasionally chemicals are added, to keep the solution at the pre-fixed strength. LPG is washed with caustic and finished with water.

Materials of Construction—Tubes in naphtha reformer furnace B-1 and combination furnace B-2 are made of alloy steel containing 5 percent chromium and 0.5 percent molybdenum. The shell of combination tower E-1 is carbon steel, lined with 11-13 Cr 0.5 Mo alloy steel plate up to the gas oil pan. The lining consists of strips welded to the shell. Trays and baffles up to and including the gas oil pan as well as the visbreaker pan itself are made of 11-13 Cr 0.5 Mo alloy steel. The baffles above the gas oil pan are carbon steel, the trays cast iron.

Vacuum tower E-2 similar to combination tower E-1 has the shell made of carbon steel and the 11-13 Cr 0.5 Mo alloy steel strip lining up to the heavy gas oil pan. Trays up to this pan, the pan itself as well as the two trays immediately above are 11-13 Cr 0.5 Mo alloy steel. The other trays, as well as the suction pan for light gas oil are carbon steel. Clay towers D-1 and D-2, after-fractionator E-4, absorber E-5, and stabilizer E-7 are all carbon steel. Process piping, valves and fittings below 600 F. are carbon steel. Above this temperature the material is 5 Cr 0.5 Mo alloy steel.

Exchangers and box coolers are carbon steel. The pump material for service under 600 F. is cast iron, their shafts 11-13 Cr 0.5 Mo alloy steel. Above 600 F. the pumps are made entirely of 11-13 Cr 0.5 Mo alloy steel.

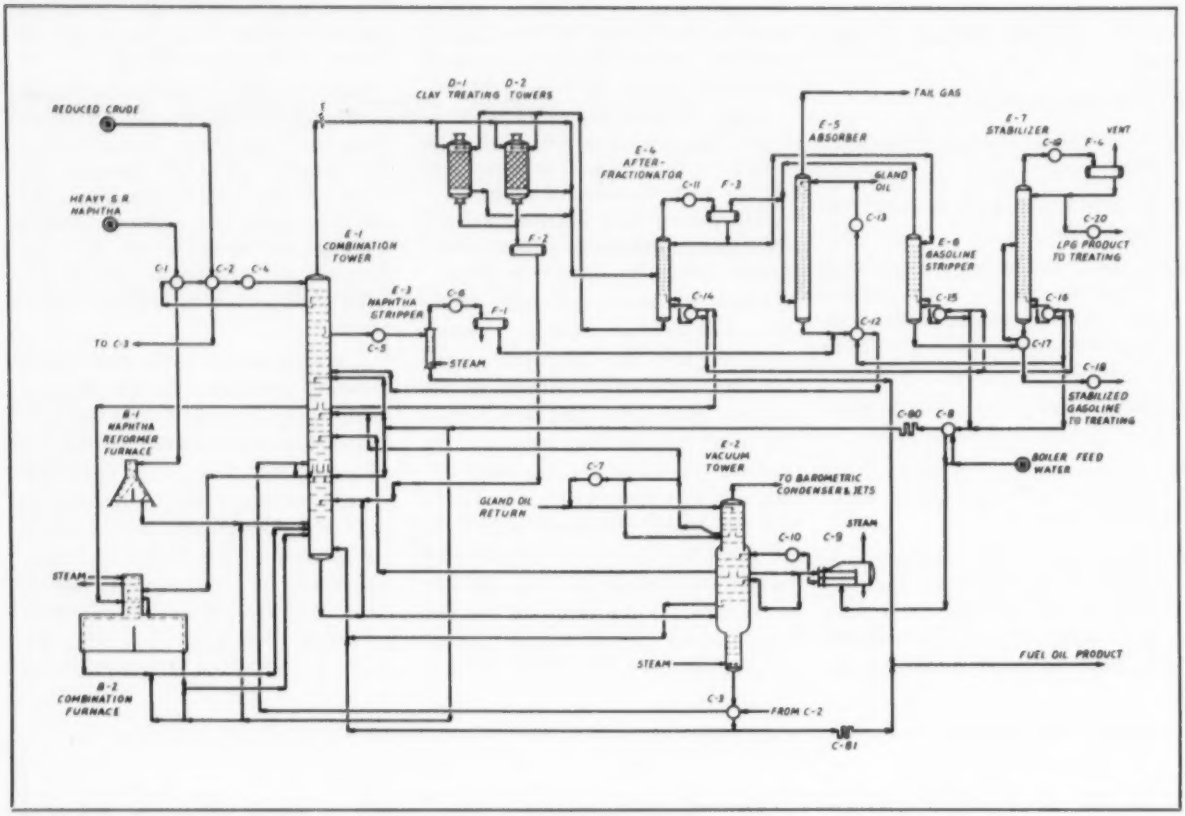

FIGURE 1—Flow scheme for new refinery. Combination design saves on operating costs and off-site facilities.

has an acoustic alarm which can be set at any desired point of the scale.

Changes in quality of the reduced crude intake or in fractionation in the combination tower can immediately be seen on this instrument. Small variations in the severity of cracking are also recorded because higher severity tends to give a slightly darker gas oil recycle.

Another new instrument is the photo cell at the outlet of the doctor treating stage. If for some reason the "break" (the precipitation of the lead mercaptides) does not occur, the outgoing gasoline stream suddenly becomes black. The photo cell coupled with an acoustic alarm in the control room immediately calls the operator's attention to this irregularity.

After completion of the 21-day test run (July, 1955), the plant was found to be clean including furnace coils, transfer lines from the furnaces to the combination tower E-1, the sump of this tower and the vacuum tower E-2 (as well as the lines between them). No indication has yet been obtained on which factor should limit the length of a run.

ACKNOWLEDGMENT

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Meet the Author

FREDRIK SAGER is a native of Austria and a citizen of Sweden. He started his refining career with the Shell Group in Rumania in 1926, shortly after completing a degree in chemical engineering at Vienna's Technical University. The following year, he joined Universal Oil Products Company and participated in the start up of Europe's first Dubbs Cracking plant. He joined A. B. Separator Nobel in Stockholm in 1932 and by 1949 had become managing director. Now with Kellogg International Corporation, he is project manager in London. Dr. Sager is author of a number of technical articles published abroad and a member of several European engineering societies.

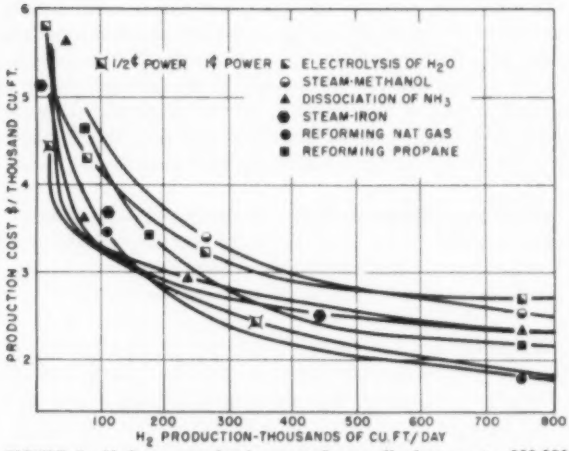

FIGURE 1—Hydrogen production cost for small plant up to 800,000 cubic feet per day.

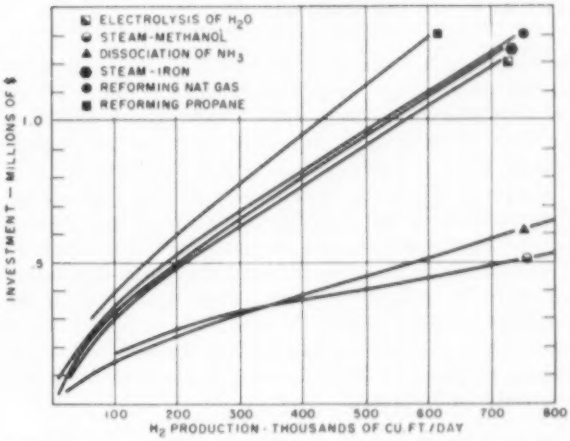

FIGURE 2—Investment requirements for small hydrogen production plant.

What Price Hydrogen?

Here are cost data to help you plan for hydrogen production in the range of 15,000 to 16 million scf per day.

Hugh Fairclough
E. I. duPont de Nemours & Company
Wilmington, Delaware

INVESTMENT AND PRODUCTION costs for plants in the range of from 15 thousand to 16 million standard cubic feet per day of hydrogen of sufficient purity for chemical manufacture are presented in Figures 1 through 4. It is intended that these Figures be used to make preliminary comparisons of processes only; final selection must be made on the basis of more detailed studies. Figures 1 and 2 are for the low range, 15-800 thousand scf per day, while Figures 3 and 4 are for the high range, 0.5-16 million scf per day (as 100 percent hydrogen). Seven processes are compared; in addition, two feed stock variables are considered for the large capacity plants. Flow diagrams are not presented as they have appeared in most of the reference articles. Final product is at least 97 percent hydrogen in all cases except from the process using dissociation of ammonia, which results in a 75 percent hydrogen, 25 percent nitrogen mixture. In all processes carbon monoxide, oxygen, hydrogen sulfide and carbon dioxide are generally less than 10 ppm, and in some cases are less than 1 ppm.

Basis for Costs—For the low production range, the figures show that steam-methanol units or ammonia dissociation units give both low investment and production costs. In the intermediate range, 150 thousand to 1 million scf per day, reforming natural gas and electrolysis of water (where power is available at ½ cent per kwh.) give low production costs. In the high production range, purifying refinery off-gas with liquid nitrogen scrubbing gives the lowest investment and production cost. These conclusions are based on raw mateirals, service, and other costs as follows:

Natural gas	$ 0.30/million Btu
Fuel Oil	2.50/bbl.
Propane	0.11/gal.
Methanol	0.30/gal.
Refinery Off-Gas	0.50/Mcf of H_2
Ammonia	90.00/ton
Coke	18.50/ton
Steam—125 psig	0.50/M lb.
Cooling Water	0.02/M gal.
Electric Power	0.01/kwh. & $0.005 as noted
Labor	$50,000/year/man/24-hr. day (incl. supervision)
Depreciation	10% of investment/yr.
Repairs and Replacement	5% of investment/yr.
Taxes, Insurance, etc.	2¼% of investment/yr.

Investment includes cost of allocated facilities for furnishing utilities and disposing of waste streams.

Discussion of Processes—Twenty-five methods of producing hydrogen, some of which were primarily of academic interest, were discussed by Brownlie[5] in 1938. Today large scale hydrogen plants generally use methods

developed later than 1938, the most recent plants using partial oxidation of hydrocarbon gases,[10] fuel oil,[13] or refinery off-gas.[7] Usually these plants furnish hydrogen for the production of ammonia, urea or ammonium nitrate. Since oxygen used in partial oxidation units is generally produced in air separation plants, large quantities of nitrogen are available, some as low-temperature liquid. This liquid is used to scrub impurities[1] such as hydrocarbons, carbon monoxide,[11] etc., from the crude hydrogen in a liquid nitrogen wash tower, giving an overhead product usually 90 percent hydrogen, 10 percent nitrogen. Gaseous nitrogen is blended with this stream to give the 75-25 percent mixture required for ammonia synthesis.[4, 11]

Electrolysis of Water—High-purity hydrogen, usually 99.95 percent or higher, is produced directly by the electrolysis of water. The major impurity, oxygen, is removed in a catalytic unit, other impurities are removed in adsorbent beds which are periodically regenerated. Production costs shown in Figures 1 and 3 are for hydrogen at 15 pounds per square inch gage. The effect of variation in power cost is shown by two curves, one of which includes power at 1¢/kwh, and the other power at ½¢/kwh. Investment given in Figures 2 and 4 include switchgear and rectifier costs, but in some localities it is possible that the utility company furnishing the power will furnish it as D.C., thus reducing the investment in the hydrogen producing facilities.

Steam-Methanol—Catalytic cracking of methanol at the relatively low temperature of 350 C. and at 300 psig results in the formation of hydrogen and carbon dioxide which is usually removed by absorbing it in an amine solution.[9] Any carbon monoxide present is catalytically converted to methane. As is shown in the Figures 1-4, these are low-investment, high-ingredient cost plants. Product is available at 300 psig. Where production for a limited period is required or where off-grade or contaminated alcohols are available at low cost, this method of producing hydrogen should be considered.

Ammonia Dissociation[12]—These are low-investment, high ingredient cost catalytic units that are suitable for short-term hydrogen production where 75 percent hydrogen-25 percent nitrogen at 15 psig can be used.

Steam-Iron—This cyclic catalytic operation is essentially a high-temperature process for the production of hydrogen from water. The catalyst is a spathic iron ore which is reduced to iron with a reducing gas, the reducing components ($H_2 + CO$) of which are at least 150 percent of the volume of hydrogen to be produced. For the cost data of this article, we have assumed the reducing medium is a producer gas made from coke, but vent gas having a relatively low percentage of reducing components could be used. Ninety-nine percent hydrogen is produced by the generators, the other 1 percent being low concentrations of carbon monoxide, carbon dioxide and nitrogen. Ninety percent of the carbon monoxide is catalytically shifted to carbon dioxide which is then removed by a caustic scrubber; the balance of the carbon monoxide is catalytically converted to methane. The final product is usually 99.7 percent hydrogen, the balance being largely nitrogen with a small percentage of methane. The gas is available at 15 psig. Should a reducing gas be on hand, the investment could be reduced about 25 percent and the production cost reduced about one-third. The cost of the reducing gas must then be added to the production cost.

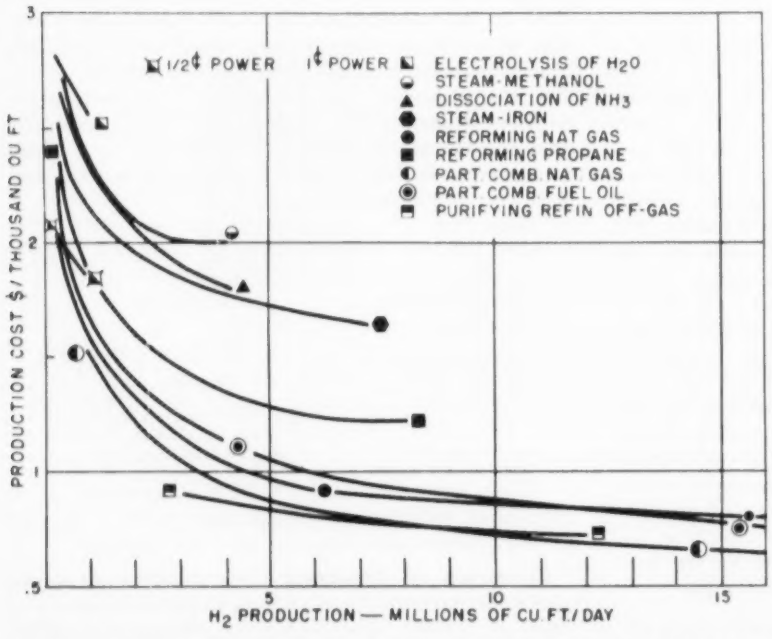

FIGURE 3—Hydrogen production cost for large plant up to 15 million cubic feet per day.

Reforming Natural Gas or Propane[9]—Since 1930 numerous hydrogen units using this process have been installed by refineries, chemical, and ordnance plants. Many of the older plants operated at substantially atmospheric pressure; the results presented here are based on the catalytic reformers and scrubbing system operating at 15 psig, but latest designs are projected at 75 psig and possibly higher pressures. Gas from the reformers is about 70 percent hydrogen, the balance being carbon monoxide, carbon dioxide, and a small amount of methane. The carbon monoxide is catalytically shifted to carbon dioxide in two stages; the carbon dioxide is then removed by amine absorption, after which the residual carbon monoxide is catalytically converted to methane. Alternatively the carbon monoxide may be removed by copper liquor scrubbing. Product hydrogen is 99.5 percent or higher unless natural gas used in the process contains nitrogen. By installing only one car-

bon monoxide converter plus a methanator, 98 percent hydrogen can be produced. This would be satisfactory for most hydrogenations. The investment and production cost curves in this article, however, are based on two stages of shifting.

Partial Combustion of Natural Gas[10] or Fuel Oil[13]—The first American plant using partial combustion of natural gas to produce hydrogen went on stream in February, 1954. The process is adequately described in the reference article. This process utilizes an air separation plant for production of the required amounts of oxygen and nitrogen (some of which is liquid). The oxygen and natural gas, hydrocarbon, or fuel oil are oxidized in a special reactor which operates at 275 psig or higher pressure to produce hydrogen, carbon monoxide, carbon dioxide, and small amounts of other materials. The carbon monoxide is catalytically converted to carbon dioxide which is removed as mentioned previously; liquid nitrogen is used to scrub out the residual carbon monoxide and other impurities. Hydrogen of 97 percent purity is obtained if additional cooling is supplied by expansion of liquid nitrogen in a cold exchanger; this is the basis for the costs presented here. For ammonia synthesis, however, 90 percent hydrogen which is obtainable as overhead gas from the liquid nitrogen wash tower is adequate as additional gaseous nitrogen is introduced later. Hydrogen from this process is available at 250 psig or higher.

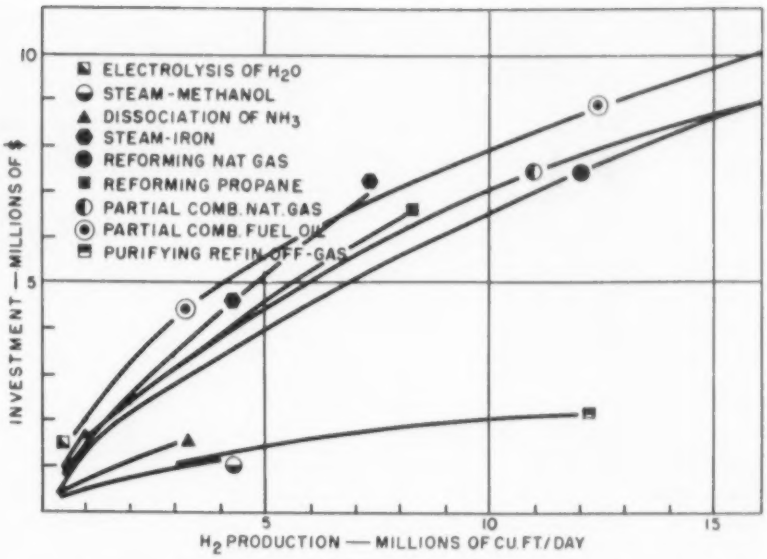

FIGURE 4—Investment requirements for large hydrogen production plant.

While the fuel oil reactors reportedly have more capacity than the natural gas reactors under the same conditions of operation, the hydrogen concentration in the raw product gas is somewhat lower, thus the scrubbing system absorbers are slightly larger. The difference in investment for the two systems is roughly comprised of oil storage and handling facilities.

Refinery Off-Gas—Of the several methods of purifying refinery off-gas (at least 55 percent hydrogen and low carbon dioxide content) that have been proposed,[2,3,6,7,8] washing with liquid nitrogen from an integrated air separation plant was selected for presentation. Since refinery gases are usually available at pressures up to 400 psig, the wash tower would operate at the available pressure. Additional cooling to produce 97 percent hydrogen is obtained from the expansion of nitrogen in a cold exchanger, but if 90 percent hydrogen is a satisfactory product, the cold exchanger would not be required. The investment shown in Figure 3 includes the cost ($150,000-$200,000) of a representative crude hydrogen line four miles in length. The production cost (Figure 4) involves no debit or credit for the fuel value of the hydrocarbons contained in the crude hydrogen since the refinery and the hydrogen consuming plant could trade fuels, or the nitrogen could be flashed from the hydrocarbons and these could be returned.

ACKNOWLEDGMENT

The writer wishes to thank the many people within the du Pont organization who have contributed ideas, especially C. H. Winter, Sr., who provided considerable background.

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Meet the Author

HUGH FAIRCLOUGH is a consultant on hydrocarbon cracking and the production of industrial gases, in the Engineering department of E. I. du Pont de Nemours & Company. Previously with The Dow Chemical Company at Midland, Mich., he has spent some 28 years in chemical plants, engaged in research, development, design, construction and operation of various units. His work chiefly has been on the design of ethylene plants and plants using ethylene and other gases as raw materials. Faircloth was educated at Case Institute of Technology, receiving a B.S. degree in mechanical engineering in 1927 and a mechanical engineer's degree in 1940.

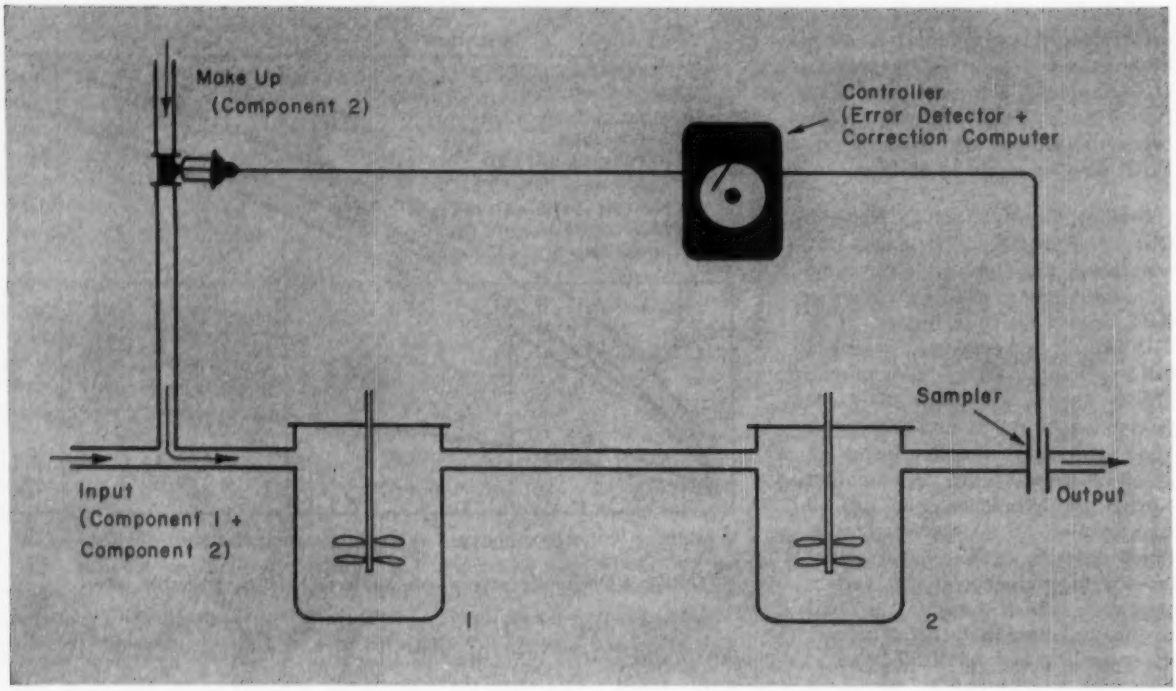

FIGURE 39—Component 2 is added to the system to maintain the output at a constant composition. The true time delay is the time required for the material to flow through the connecting pipes.

Automation Today

Part 6

Here is an example problem which summarizes many of the control principles discussed in preceding parts of this series.

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IN THIS ARTICLE we wish to consolidate the information presented in the previous articles of this series by showing its use in the design of the control system for a relatively simple process.

ILLUSTRATIVE EXAMPLE

Let us use as an example for discussion a mixing system similar to that used previously in this series of articles (Part 3). The specific system is shown in Figure 39. It consists of two mixing kettles with a function to insure thorough mixing of an input stream and a make-up stream which is added in order to keep the output flow at a constant composition. If it is known that the input stream will always be in error toward the lean side in component 2 the function of the makeup stream must always be to add the correct amount of this component. Now we will continuously sample the output stream and determine any resulting error between its actual composition and that desired. Finally, this error will be used to adjust a valve in the make-up line. We thus have all of the necessary elements for our control system. Figure 40 gives the block diagram of this system as was described in Part 1.

The time constants of the system can be developed as follows:

1. Assume that a standard one inch wrought iron pipe

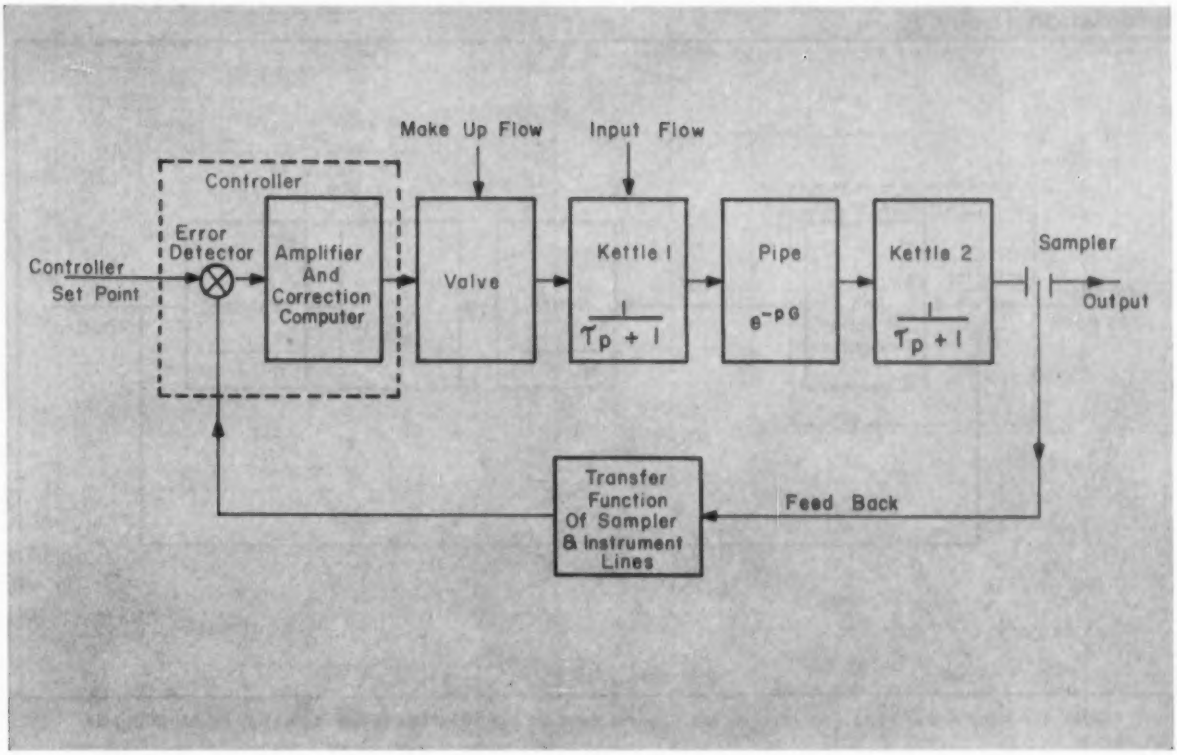

FIGURE 40—The control elements of the example problem may be represented by a block diagram showing each transfer function.

connects the various elements of the system. Assume also that the liquid flows through this pipe at one foot per second. The rate of flow will therefore be:

$$F = \frac{\pi\ (\text{dia.})^2}{4}(\text{velocity}) = \frac{(3.14)\left(\frac{1.049}{12}\right)^2}{4}(1) = 0.006\ \text{ft}^3/\text{second} = 0.045\ \text{gallons/second.}$$

If the capacity of each kettle is given as 45 gallons, their time constants are

$$\tau_1 = \tau_2 = \frac{C}{F} = \frac{45}{0.045} = 1000\ \text{seconds}$$

2. If we require a total of 100 feet of pipe to connect between the valve and first kettle, between the two kettles, and between the last kettle and the sampler, the time delay involved in the pipe at a liquid velocity of one foot per second is

$$G = \frac{100}{1} = 100\ \text{seconds.}$$

3. The sampler, the instrument lines, and the valve will themselves have transfer functions and therefore time constants as we know. However, one of the common simplifying rules which is applied to the design of control systems states that—if a transfer function has a time constant whose value is less than one-tenth of that of the longest time constant of the process its effect upon the process can be ignored.[7] Since the time constants of these devices are usually of the order of a few seconds they will be neglected in this study as their presence would only serve to add complexity to our development. If he desires, the reader may assign a first order transfer function with a time constant of 50 seconds to each of these items and satisfy

Here Is the General Procedure For Selecting a Control System

The method of procedure outlined in this series for determining a control system can be summarized as follows:

- Determine the transfer functions of the various units of the process and all associated time constants.
- Draw the Bode diagram of the system without a controller present.
- Using this Bode diagram of the system add various amounts of proportional, derivative, and/or integral control until the best final control is obtained. Be sure to keep an adequate phase margin, and remember that with derivative and integral control both τ_c and α or β may be varied at will. The best control is of course the one which allows the highest proportional gain provided any derivative action needed to speed up the system or integral action needed to eliminate steady state error is also present. We would therefore select that control instrument whose characteristics most nearly matched those determined as optimum in our theoretical analysis.

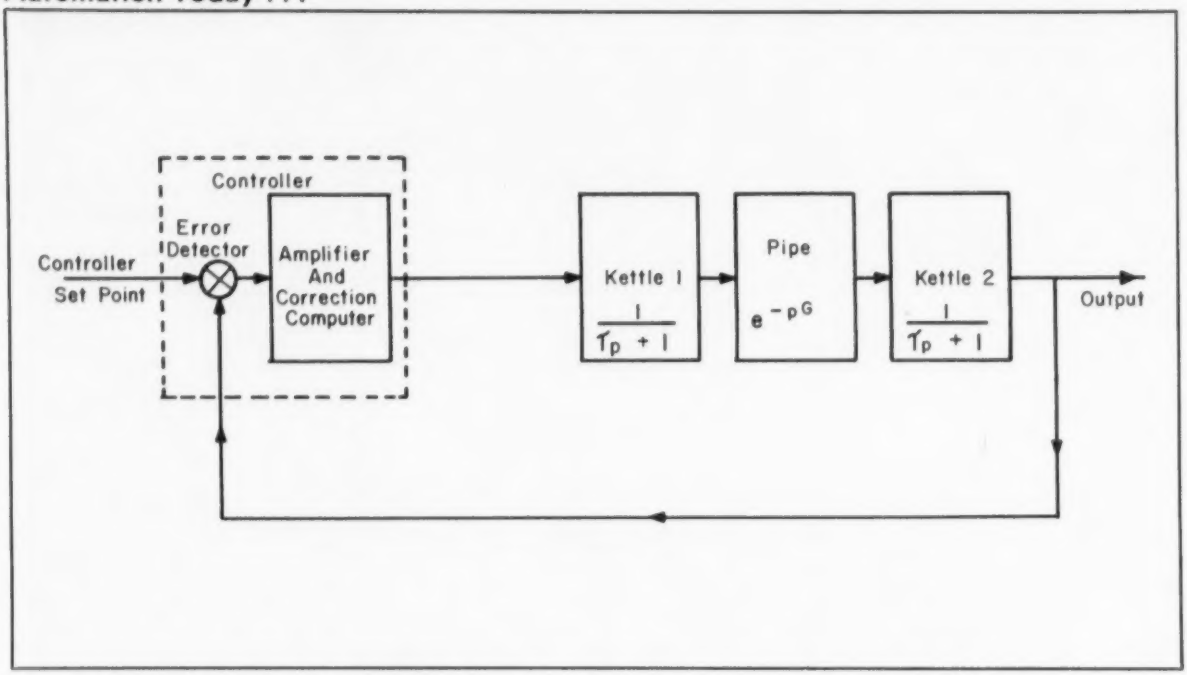

FIGURE 41—Those devices which have relatively small transfer functions may be omitted in order to simplify the block diagram.

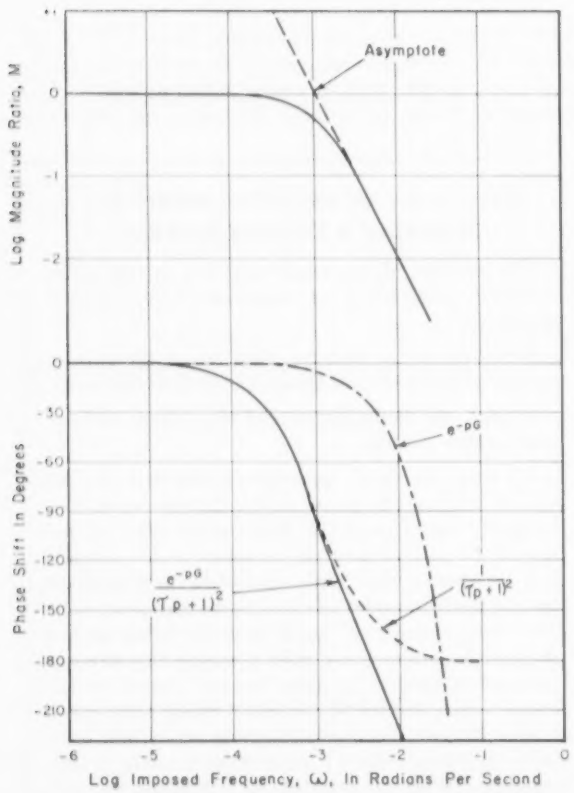

FIGURE 42—The first step is to draw the Bode diagram of the system without any controller action.

himself that they would have no effect by carrying out an analysis according to the method to be discussed here.

4. The simplified diagram for this process is shown in Figure 41. The transfer functions of the various controller actions will be represented on the Bode diagram as we proceed.

BODE DIAGRAM OF THE SYSTEM

The first step in our development will be to draw the Bode diagram of the system without any controller action using the method outlined in Part 5. The resulting diagram is given as Figure 42. Since the time constants of the kettles are the same they may be consolidated and represented as $\frac{1}{(\tau p + 1)^2}$. The phase shift (Ψ) of the true time delay period (G) of the 100 feet of pipe is calculated for the frequencies of imposed sinusoidal variations (ω) according to the formula given in Part 5:

$$\psi = 57.3\ (\omega)\ (G). \qquad (1)$$

The resulting curve labeled as e^{-pG} is shown in Figure 42. The total phase shift is the sum of the phases shifts of the kettles and of the line.

Since the presence of a true time delay does not affect the magnitude ratio of the process, it will be the same as that for the function $\frac{1}{(\tau p + 1)^2}$.

We may now develop a control plan for the system by including the effects of our postulated controller in the Bode diagram of the system which we have just drawn. This we can do by adding in the log magnitude ratio and phase shift of its components just as we included the log magnitude ratio and phase shift of each of the other important components of our mixing system.

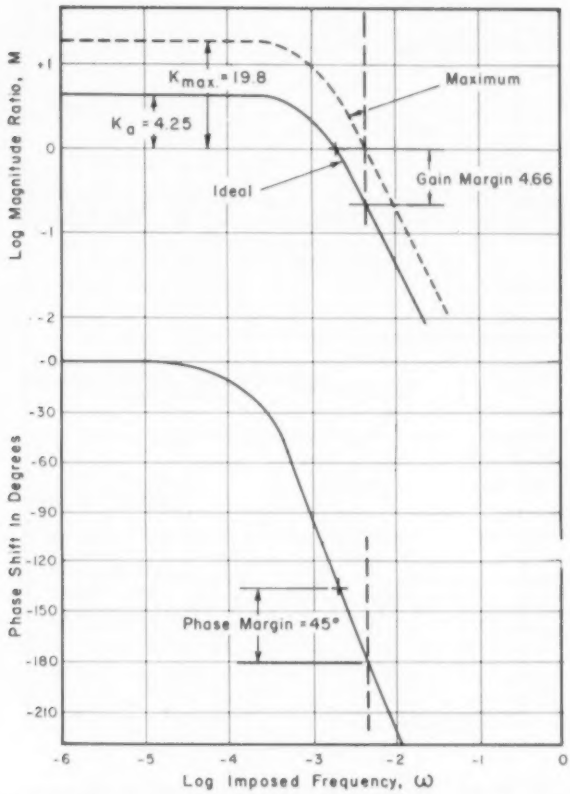

FIGURE 43—A proportional control will increase the magnitude ratio but does not affect the phase shift. If the magnitude ratio is increased above zero at a phase shift of —180 degrees, oscillation will occur.

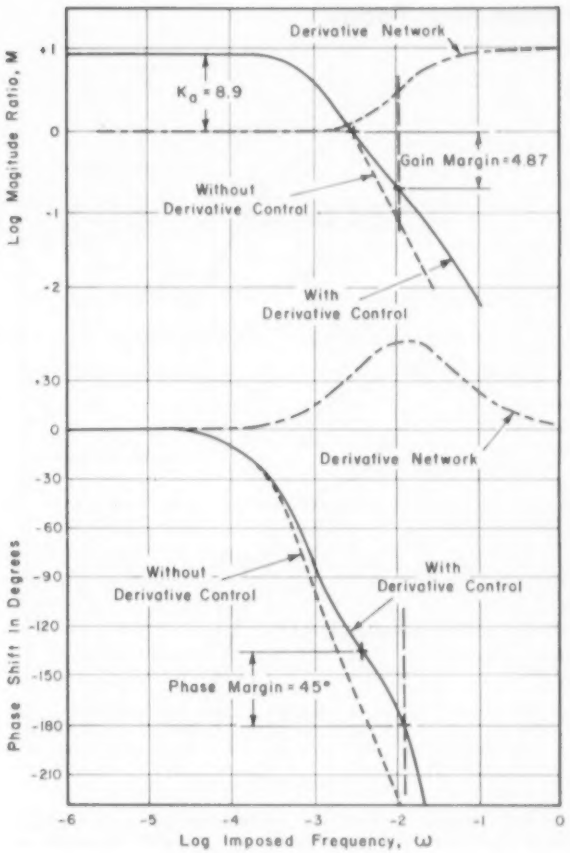

FIGURE 44—The control action of the network may be sped up by adding a derivative control to the proportional control.

PROPORTIONAL CONTROL

It was stated in Part 4 that the phase shift of a system must be greater than 180 degrees for instability to occur and that even then it would occur only if the magnitude ratio remained greater than 1.0 for phase shifts of 180 degrees or more. It can be seen therefore that if the true time delay of the connecting pipe were not present this system would be stable under most conditions since its time delay would never exceed 180 degrees. However, because of the very low magnitude ratios and large time constants present it would be a very sluggish system with quite large errors.

One way of rectifying the presence of a large error is to add proportional control. Proportional control increases the magnitude ratio but does not affect the phase shift. The magnitude ratio can only be increased, however, until its value becomes 1.0 at that frequency at which the phase shift reaches 180 degrees as we have just mentioned. In our present example this factor, K_{max}, amounts to 19.8 when sustained oscillation ($\Psi = 180$ degrees) occurs. Any larger value will of course cause instability.

However, oscillations are very undesirable in a control system, so some control engineers have adopted the rule that the minimum phase margin must be at least 45 degrees (i.e., $\Psi \leq 135$ degrees) whenever the magnitude ratio is greater than one ($M > 1.0$).[12] In our present example this requirement limits our allowed proportional gain, K_a, to 4.25, and results in a gain margin (or maximum additional gain) of 4.66 at $\Psi = 180$ degrees. The reader should notice that

$$K_a = \frac{K_{max}}{\text{Gain Margin}} \qquad (2)$$

Figure 43 illustrates these points.

PROPORTIONAL PLUS DERIVATIVE CONTROL

As was mentioned in Part 3, the primary function of derivative control is to speed up the action of a process. It also often has the auxiliary function of permitting a larger proportional constant to be used in the control of the process.

If we let $\tau_c = 258$ seconds and $\alpha = 0.1$, we will have $\tau_1 = 258$ seconds and $\tau_2 = 25.8$ seconds (see Figure 37, Part 5). As given there and in Part 3 the equation for derivative action is

$$\frac{\Delta F}{E} = \frac{\tau_c p + 1}{\tau_c \alpha p + 1} = \frac{\tau_1 p + 1}{\tau_2 p + 1} \qquad (3)$$

The effect of the derivative circuit or other such device represented by the time constants above on our example is shown in Figure 44. By decreasing the phase shift at the higher frequencies we have succeeded in increasing the allowable gain to 8.9, a factor of better than two com-

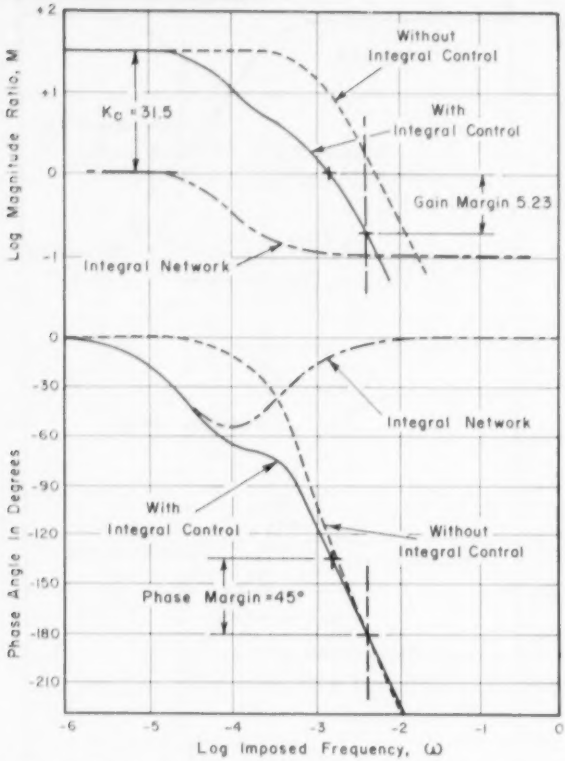

FIGURE 45—Integral control added to proportional control gives greater gain at low frequencies but reduces the gain at higher frequencies so that the response is sluggish.

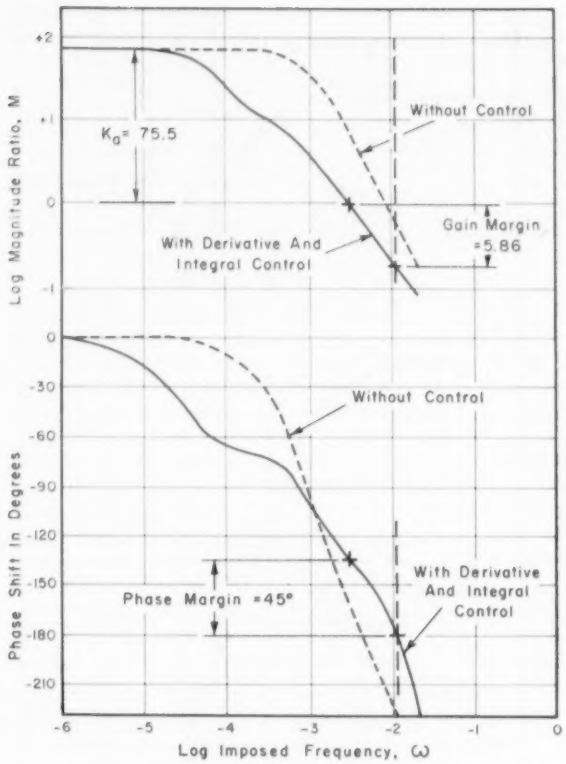

FIGURE 46—All three modes of control may be used on the system. In this way the allowable proportional gain can be increased to 75.5.

pared to the use of proportional control alone. In addition the speed-up action of the network will essentially eliminate the effect of one of the kettles by replacing it with one of approximately one tenth the size ($\alpha = 0.1$). If $\tau_c = 1000$ this would have been exactly the case (see Part 3). However, this latter would not have allowed as large an increase in proportional gain so it was not used here.

PROPORTIONAL PLUS INTEGRAL CONTROL

Similarly integral control using a value of $\tau_c = 3180$ and $\beta = 10$ will give a value of $\tau_1 = 3180$ and of $\tau_2 = 31800$ (see Figure 38, Part 5). These symbols are part of the equations

$$\frac{\Delta F}{E} = \frac{\tau_c' p + 1}{\tau_c' \beta p + 1} = \frac{\tau_1' p + 1}{\tau_2' p + 1} \qquad (4)$$

as discussed also in Part 3 and Part 5.

The effect of this integral network on our mixing system example is shown in Figure 45. Integral control has made possible an increase in the allowable proportional gain to 31.5. However, this is true only on very low frequencies. It has also resulted in cutting the effective gain at the higher frequencies because of the approximately 10 to 1 magnitude ratio decrease inherent in integral control ($\beta = 10$). It is therefore very sluggish in its response.

USE OF ALL THREE MODES OF CONTROL

It is of course possible to use all three modes of control on the same process and this is often done. If both the integral and derivative networks of the previous discussions are combined in one controller the diagram shown in Figure 46 results. The allowable proportional gain has now been increased to 75.5 by this arrangement.

A glance at almost any textbook on the subject of servomechanisms will serve to remind the reader that we have only touched on the very simplest systems and methods so far in this series. The more advanced methods of control synthesis such as the Nichols diagram[4] and a complete discussion of the Nyguist[12] and Evans[5] methods have not yet been given. However, with the introduction we now have to the field it is felt most advantageous to consider some of the aspects of control other than theory before returning to the more advanced topics. Therefore, our next series which will appear in an early issue of PETROLEUM REFINER will concern sampling methods, types of control devices, and some aspects of plant design as it effects good control.

SYMBOLS USED

See Williams, Theodore J., "Automation Today, Part 1," PETROLEUM REFINER, vol. 35, no. 4, p. 211-214 (April, 1956).

ADDITIONAL SYMBOLS USED

- E output error as determined by sampler.
- K_a allowable proportional gain to keep a 45° phase margin.
- K_{max} maximum proportional gain without instability.
- ψ phase shift in degrees.
- ω frequency of imposed sinusoidal variation in radians per second.

Part 7 of this series will appear in a coming issue of PETROLEUM REFINER

How to Select Centrifugal Pumps

There is an economical pump for each application. Here's a guide to avoid costly pump selection.

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Allis-Chalmers Manufacturing Company
Milwaukee, Wisconsin

CENTRIFUGAL PUMPS are the heart of any refinery or petrochemical process. They are called upon to transport many fluids varying from clean water to hot oils to catalyst slurries. Centrifugal pumps are as simple or as complex as required for the varied process fluids and conditions they must handle.

Basically, centrifugal pumps are called upon to perform a twofold duty:

- Pump a certain capacity in a given time, and
- Pump this capacity against a pressure or head in order to accomplish flow of the required capacity.

Capacity is usually considered in terms of U. S. gallons per minute by pump manufacturers. A few conversion factors are as follows:

1000 pounds per hour (Sp Gr. = 1.0)	2.0	U. S. gpm
1 cubic foot per second	448.8	U. S. gpm
1 imperial gallon per minute	1.2	U. S. gpm
100 barrels of oil per 24 hour day	2.92	U. S. gpm
1 liter per minute	0.2642	U. S. gpm
1 cubic meter per minute	264.	U. S. gpm

The capacity to be pumped is usually set by the process conditions. That is, a desired flow rate through a continuous process or a fixed quantity in a fixed time cycle for a batch process.

Total Pumping Head—The head to be developed is almost always partially or completely tailored for the individual pumping application. The liquid must be moved to the *suction* side of the pump and then moved to the *discharge* point in the process system. The pump does the whole job from the source (suction) liquid level to the discharge liquid level. Since centrifugal pumps are limited in their suction lifting abilities, this portion of the total head should get individual attention. It will be assumed that the reader understands the limiting factor which is wrapped up in one term—net positive suction head above vapor pressure, or NPSH. The pump selected must require less NPSH than is to be available from the system supplying its suction.

When there is a resultant negative head at the suction of the pump, this must be added to the discharge head to determine the total head the pump is to produce. If there is a positive head on the pump suction, this should be deducted from the discharge head to get the total pumping head required. This is the case when a pump is acting as a booster and has positive suction pressure at all times.

If suction and discharge heads are to vary, their full range must be considered and the limiting conditions used in selecting the pump. Some compromise can be made in selection if at the abnormally high head conditions some reduction in flow can be tolerated. In selecting

Meet the Author

JACK A. CABLE is an application engineer with Allis-Chalmers Manufacturing Company in Milwaukee, engaged in preparing quotations on specialized centrifugal pumps. With the company's Pump department 21 years, Cable started as a drafting apprentice, serving subsequently as head of the Pump Repair department and in liaison with the Advertising department before he was made an application engineer in 1948. Since then, he has worked in the plant where Allis-Chalmers manufactures its single suction-type pumps and in the plant where larger pumps are made. He is a former student at the University of Wisconsin and at the University of Cincinnati, and author of a number of articles on various phases of centrifugal pump design and application.

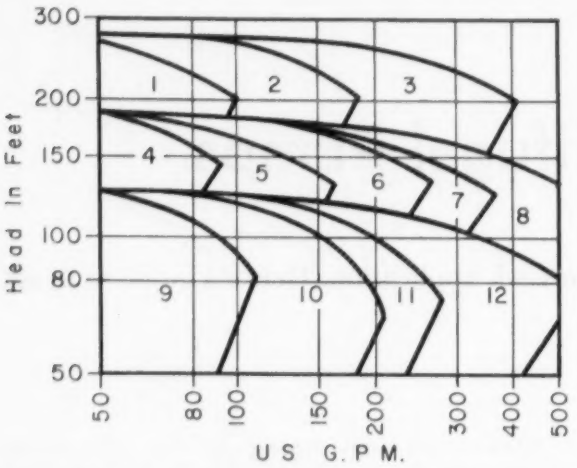
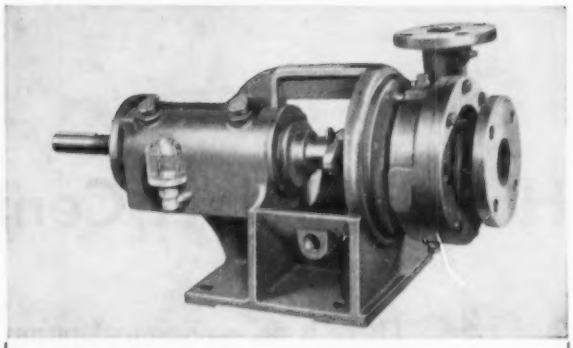


FIGURE 1 (above)—Single suction, 3600 rpm, standard foot mounted, pumps.

FIGURE 1A (right)—Standard single suction type centrifugal pump.



Mounting: Foot mounted on bearing frame.
Materials: Standard—C.I. casing, bronze fitted.
Also available—almost any cast and machineable alloys for wetted parts.
Limitations:
Temperature—Standard fitted.....0 to 212F
Special fitted as to materials and mechanical modifications.....—75 or lower to 550F
Pressure—Standard fitted.....100 to 175 psi.
Maximum with material and mechanical modifications.....200 to 300 psi.
Accessibility for Maintenance—Casing vertically split so that parts accessible horizontal require either moving suction pipe or bearing frame.
Complete Range: Capacities to 3000 to 4000 GPM.
Heads to 300 or 400 feet.

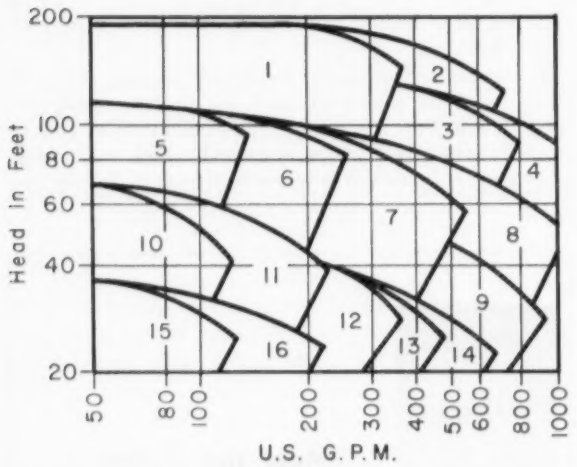


FIGURE 2—Single suction, 1800 rpm, standard foot mounted, pumps.

a pump for a particular application it should be capable of fulfilling the requirements of the full range of suction and discharge heads. For ease in converting pressure into head, a few equivalents are as follows:

1 Pound at 1.0 Sp. Gr.	2.31	feet of head
1 Inch of Mercury	1.134	feet of head
1 Meter	3.281	feet of head
1 Kilogram per square centimeter at 1.0 Sp. Gr.	32.84	feet of head
1 Atmosphere at sea level	34.0	feet of head

Pump Operating Speed—Modern pump selection tends toward the fastest operating speed for the pump rating. This usually results in the smallest pump. Usually this means lower initial costs and is good practice unless there are extenuating circumstances. Conditions of very high suction lifts or fluids containing abrasive solids in suspension may result in selection of lower speed pumps. High suction lifts, up to about 30 feet can be handled by special selection, and usually result in larger and/or slower speed pumps.

Conversely, suction conditions of positive pressure (in excess of 15 feet) warrant special consideration. Favorable conditions such as these may permit the selection of a smaller or higher speed pump than would be indicated from the standard charts. The problem of suspended solids can be solved with specialized solids handling or rubber lined pumps which, though not covered in these charts, are readily available.

The charts that follow (Figures 1-5 and Tables 1-8) consider pumps for clean liquids. Suctions conditions up to 15 feet of lift are provided for in accordance with usual pump industry practice.

Types of Pumps—Three different types of pumps used in various applications of refinery pumping will be discussed. An application requiring low initial cost would use a standard **single suction type of pump** (Figures 1, 1A and 2). This design can be readily modified with water cooled stuffing box, mechanical seals, etc. Also because of pattern and casting procedures, single suction casings are more easily made of alloys and stainless materials.

Double suction pumps (Figures 3, 3A and 4) are somewhat more reliable because they have bearings straddling the impeller. They generally are capable of greater suction lifts in respective sizes because of the larger inlet area at the eye of the impeller. Where frequent inspection and maintenance is anticipated, the horizontally split casing provides an advantage as neither the suction nor the discharge piping need be disconnected.

Refinery process type pumps (Figures 5 and 5A) are especially adapted for high temperature applications. They are designed to safely contain high-pressure volatile liquids.

Pump Selection and Costs—The pumps listed in the following tables (Tables 1-6) are standard fitted with baseplate and coupling arranged for but not including electric motor drive.

TABLE 1—Pumps selected from Figure 1, 3600 rpm, Single suction (Standard foot mounted)

Key No.	Suction and Discharge	Approximate Cost	Horsepower Range at 1.0 Sp. Gr.
1	2 x 1½	$175.00	5 —15
2	2½ x 2	225.00	7½—15
3	3 x 3	275.00	15—25
4	1½ x 1¼	175.00	3 — 5
5	2 x 1½	200.00	3 — 7½
6	2½ x 2	225.00	5 —10
7	3 x 2½	250.00	7½—15
8	4 x 3	275.00	10 —20
9	1½ x 1½	125.00	1 — 3
10	2 x 2	150.00	1½— 5
11	2½ x 2½	175.00	3 — 7½
12	3 x 3	200.00	5 —15

TABLE 2—Pumps selected from Figure 2, 1800 rpm (Unless otherwise marked), single suction (Standard foot mounted)

Key No.	Suction and Discharge	Approximate Cost	Horsepower Range at 1.0 Sp. Gr.
1	4 x 3	$400.00	7½—25
2	6 x 4	450.00	20 —30
3	4 x 3	400.00	15 —25
4	5 x 4	500.00	15 —30
5	2 x 1½	250.00	2 — 7½
6	2½ x 2	350.00	3 —10
7	4 x 3	400.00	5 —15
8	5 x 4	450.00	7½—20
9	5 x 4 (1200 rpm)	500.00	3 — 7½
10	1½ x 1½	225.00	1 — 2
11	2 x 2	250.00	1½— 3
12	3 x 2½ (1200 rpm)	350.00	1½— 3
13	4 x 3 (1200 rpm)	400.00	2 — 5
14	5 x 4 (1200 rpm)	450.00	2 — 5
15	2½ x 2½	175.00	¾— 1½
16	3 x 3	200.00	1 — 2

TABLE 3—Pumps selected from Figure 3, 3600 rpm, double suction

Key No.	Suction and Discharge	Approximate Cost	Horsepower Range at 1.0 Sp. Gr.
1	3 x 2½	$550.00	15—40
2	4 x 3	575.00	30—50
3	4 x 3	550.00	15—40
4	2 x 1½	400.00	3—15
5	2½ x 2	450.00	3—20
6	3 x 2½	500.00	5—25

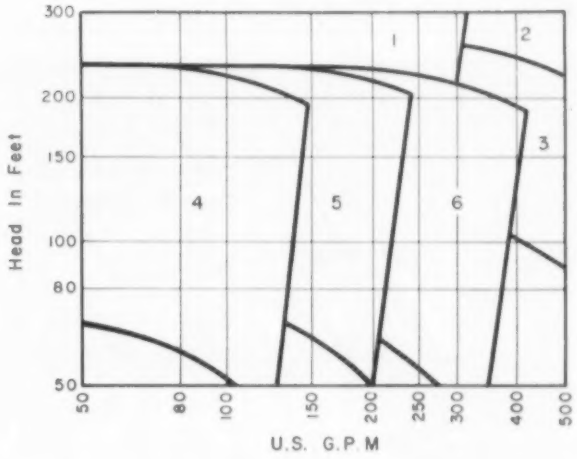
TABLE 4—Pumps selected from Figure 4, 1800 rpm, double suction

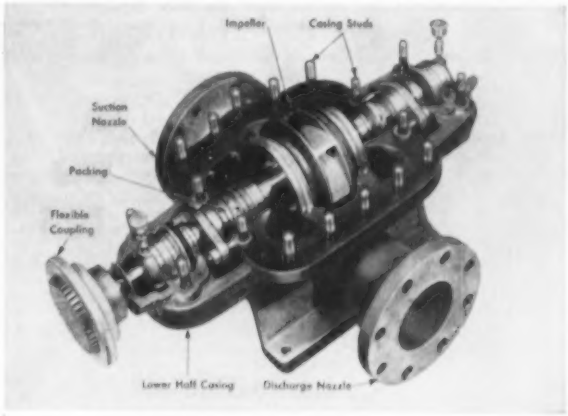
Key No.	Suction and Discharge	Approximate Cost	Horsepower Range at 1.0 Sp. Gr.
1	5 x 4	$750.00	40 —60
2	4 x 3	650.00	20 —40
3	3 x 2½	550.00	7½—20
4	4 x 4	600.00	3 —20
5	5 x 5	650.00	5 —30
6	2 x 1½	400.00	¾— 2
7	2½ x 2	450.00	1 — 3
8	3 x 2½	500.00	2 — 7½
9	4 x 3	550.00	2 — 7½

FIGURE 3 (top)—Double suction, 3600 rpm, standard foot mounted, pumps.

FIGURE 3A (middle)—Double suction type centrifugal pump.

FIGURE 4 (bottom)—Double suction, 1800 rpm, standard foot mounted, pumps.



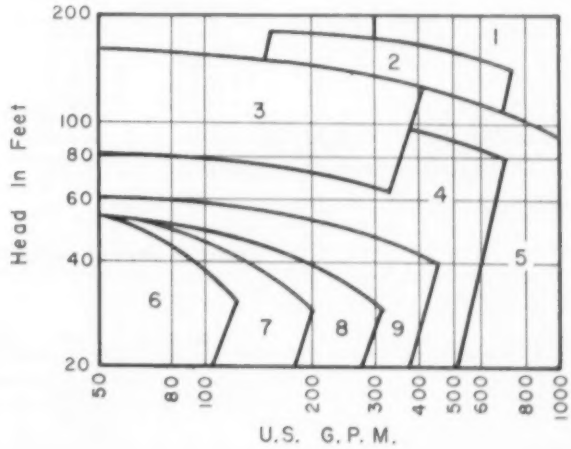


Mounting: Foot mounted on feet cast integral with casing.
Materials: Standard—Cast iron casing, bronze fitted.
Also available in many alloys although more limited than single suction types.

Limitations:
Temperature—Standard fitted ..... 0 to 212F
Special fitted as to materials and mechanical modifications ..... —75 or lower to 300F
Pressure—Standard Fitted ..... 100 to 175 psi.
Maximum with material and mechanical modifications ..... 200 to 300 psi.

Accessibility for Maintenance—Casing horizontal split so that rotating parts lift out vertically.

Complete Range: Capacities almost unlimited. Heads to 500 or 600 feet in single stage units.



How to Select Centrifugal Pumps . . .

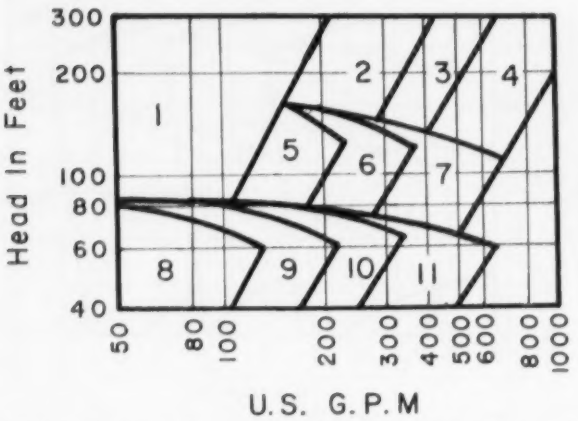
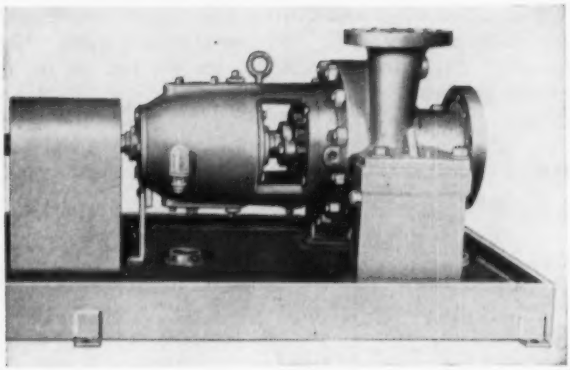


FIGURE 5 (above)—Single suction, 3600 and 1800 rpm, refinery type pumps.

FIGURE 5A (right)—Single suction centrifugal pump (refinery process type).



Mounting: Centerline support, pedestal on base can be water cooled for high temperature applications.

Materials: Standard—Carbon steel welded parts except some have cast iron impeller. Also available in almost any cast and machineable alloys for all welded parts.

Limitations:

Temperature—Standard fitted ..... 0 to 350F
Special fitted as mechanical modifications and with steel impeller ..... 0 to 800F
Other special fittings of all parts—75 or lower to 800F

Pressure—Standard ..... Up to 750 psi.
With mechanical modifications ..... Up to 1200 psi.

Accessibility for Maintenance—Casing vertically split. Parts accessible from driven end without disconnecting piping or moving motor, due to use of spacer type coupling.

Complete Range: Capacities to 1000—2000 GPM. Heads to 600—700 feet.

TABLE 5—Pumps selected from Figure 5, 3600 and 1800 rpm, single suction (Refinery process, center line mounted)

Key No.	Suction and Discharge		Approximate Cost	Horsepower Range at 1.0 Sp. Gr.
1	2 x 1½	3600 rpm	$1150.00	7½—30
2	3 x 2		1250.00	15 —50
3	4 x 3		1450.00	20 —75
4	6 x 4		1600.00	40 —125
5	3 x 2	1800 rpm	1400.00	5 —15
6	4 x 3		1500.00	7½—20
7	6 x 4		1800.00	15 —40
8	2 x 1½	1800 rpm	1150.00	1 — 5
9	3 x 2		1250.00	2 — 7½
10	4 x 3		1450.00	3 —10
11	6 x 4		1600.00	5 —15

1800 RPM versus 3600 RPM. Table 1 through Table 4, from Figures 1, 2, 3 and 4, give selections at two speeds. By referring to these tables it is possible to determine the extra cost of 1800-rpm pumps when the duty is such that it can be handled by a 3600-rpm unit. For example, a pump handling 325 gallons per minute at 100 feet total head, could be selected as shown in Table 6.

TABLE 6—Pump selection for 325 GPM at 100 feet total head

Figure No.	Table No.	Selection No.	Pump Suction and Discharge (rpm)	Approximate Cost
1	1	12	3 x 3 (3600)	$200.00
2	2	1	4 x 3 (1800)	400.00
3	3	6	3 x 2½ (3600)	500.00
4	4	3	3 x 2½ (1800)	550.00
5*	5	6	4 x 3 (1800)	1500.00

* A centerline mounted unit would result in this choice and approximate costs, if first cost is of concern, use centerline mounting only if necessary.

Materials of Construction—The example shown in Table 6 considers each pump with standard materials and mechanical construction. The variations will become more pronounced for any special material of construction for the wetted parts. Additions to cost for special materials may vary considerably between different manufacturers but will probably fall within the range indicated in Table 7.

TABLE 7—Additional Cost for Various Materials of Construction (Wetted parts)

Materials for all Wetted Parts	Percentage Additions		
	Figure 1 and 2 Pumps	Figure 3 and 4 Pumps	Figure 5 Pumps
Cast Iron	0—5%	0—5%	Not Avail.
Bronzes, various	40—125%	75—140%	0—25%—if available
Carbon Steel	100—150%	125—200%	0—1%
18-8 Stainless Steel	150—200%	175—250%	75—125%
Chromium 20, Nickel 25, Molybdenum 2 Alloy	175—225%	200—275%	100—175%

Varying Suction Conditions—Using the same example as before, 325 gpm at a head of 100 feet, let's see the effect of changing suction conditions on pump costs.

Referring to Table 8, notice the effect that suction conditions play in pump selection. In two cases a pump is not available (3600 rpm) and two of the 1800-rpm units would have been too small. Proper consideration in the latter cases would have resulted in a usable pump well worth the small cost premium. ##

TABLE 8—Effect of Varying Suction Conditions on Pump Cost

Table No.	Figure No.	RPM	Selection		Good for		If 25 Feet Lift Needed	
			No.	Pump	Cold Water Lift	Equivalent NPSH	Selection	Added Cost
I	1	3600	12	3 x 3	21 feet	12 feet	Not available	at 3600 rpm
II	2	1800	1	4 x 3	23 feet	10 feet	No. 2 6 x 4	$50.00
III	3	3600	6	3 x 2½	18 feet	15 feet	Not available	at 3600 rpm
IV	4	1800	3	3 x 2½	20 feet	13 feet	No. 2 4 x 3	$100.00
V	5	1800	6	4 x 3	27 feet	6 feet	No. 6 is also good for this lift	

● This photograph shows the welding of Revere 70-30 Cupro-Nickel to make a digester to handle both organic and inorganic acids. The metal was chosen because of its superior corrosion-resistance. It is also widely used for condenser tubes and plates, heat exchangers, evaporators, stills and similar equipment where its enduring qualities are required to meet corrosive fluids such as salt water and many chemicals.

The digester shown was made by the Nooter Corporation, 1430 S. Second St., St. Louis 4, Mo., which is an important supplier to the chemical, refinery, utility and similar industries. Weight of the vessel, 9,000 pounds; length, nine feet, inside diameter, 66 inches. Revere collaborates closely with Nooter from time to time on welding matters. If you have a welding problem on non-ferrous metals, see the nearest Revere Sales Office.

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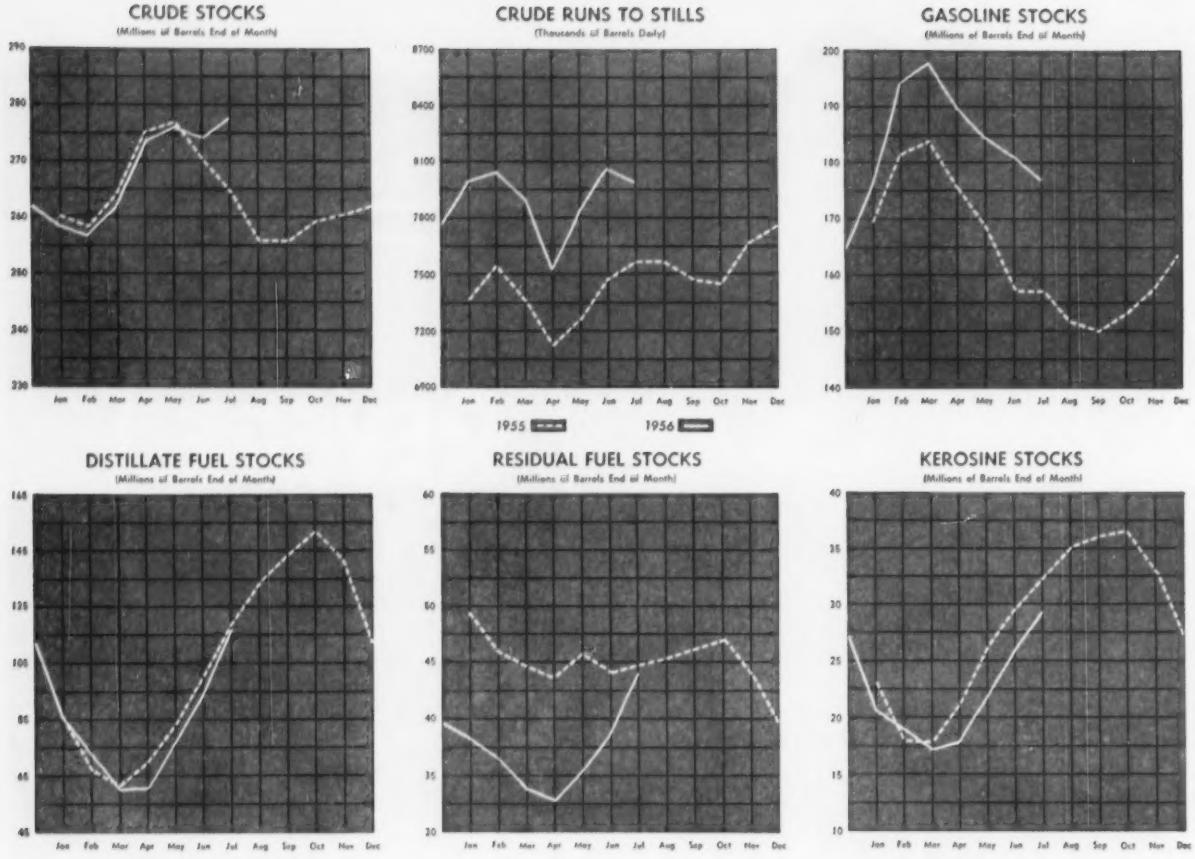

CRUDE STOCKS
(Millions of Barrels End of Month)
CRUDE RUNS TO STILLS
(Thousands of Barrels Daily)
GASOLINE STOCKS
(Millions of Barrels End of Month)
1955
1956
DISTILLATE FUEL STOCKS
(Millions of Barrels End of Month)
RESIDUAL FUEL STOCKS
(Millions of Barrels End of Month)
KEROSINE STOCKS
(Millions of Barrels End of Month)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

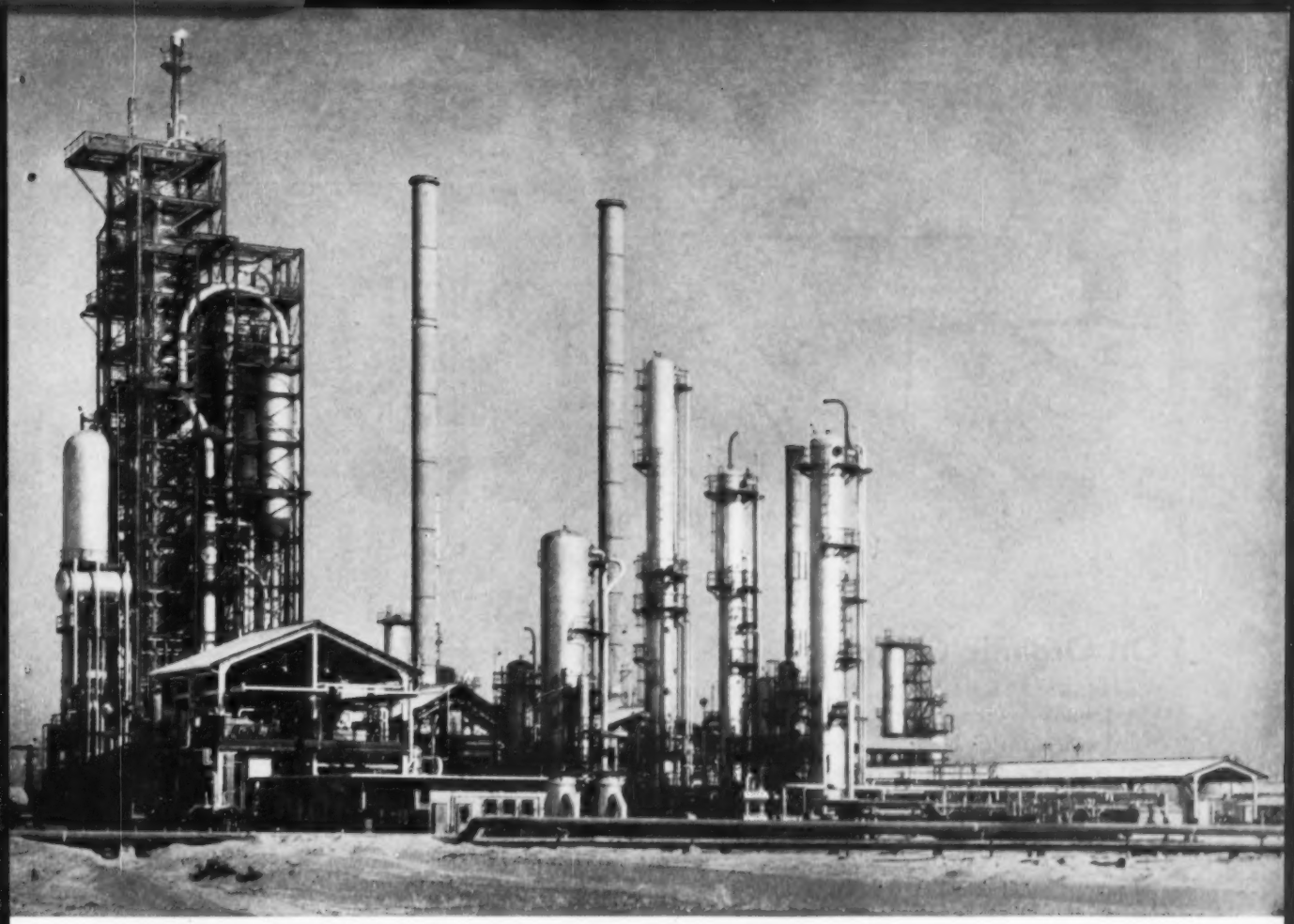
Taking Stock

Cecil W. Smith
Economics Editor

- **Gasoline stocks need trimming**
- **Distillate stocks could be hiked**
- **Refinery operations cut slightly**

MONTH	CRUDE OIL			GASOLINE		KEROSINE		DISTILLATE FUEL		RESIDUAL FUEL		DAILY IMPORTS	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Crude Oil	Total Oils
1954:													
July	6,242	6,916	284,894	3,480	158,010	295	31,953	1,416	101,657	1,089	54,365	724	1,038
August	6,168	6,862	281,043	3,492	153,168	302	34,949	1,453	117,579	1,069	56,332	664	966
September	6,151	6,939	274,608	3,511	150,916	301	37,099	1,514	128,061	1,086	56,702	672	999
October	6,135	6,834	269,442	3,457	149,661	310	37,140	1,545	139,128	1,066	56,541	642	1,065
November	6,346	6,975	264,566	3,530	150,604	354	34,547	1,622	133,886	1,120	54,891	636	1,104
December	6,394	7,238	258,385	3,605	155,400	381	27,826	1,668	108,144	1,187	52,105	729	1,301
1955:													
January	6,761	7,379	260,156	3,639	169,562	409	23,266	1,740	86,602	1,235	49,457	739	1,348
February	6,835	7,549	258,630	3,655	181,643	374	18,291	1,847	68,513	1,239	46,042	751	1,379
March	6,886	7,374	264,430	3,543	183,972	357	18,187	1,703	62,457	1,185	44,970	742	1,319
April	6,887	7,136	275,232	3,502	175,601	312	21,486	1,534	70,139	1,110	43,838	697	1,123
May	6,677	7,281	276,948	3,605	168,751	296	26,375	1,519	83,559	1,111	45,083	742	1,137
June	6,613	7,484	270,850	3,725	157,439	269	29,830	1,628	100,652	1,080	44,398	764	1,159
July	6,632	7,580	264,601	3,824	157,079	286	32,749	1,575	119,169	1,091	44,894	860	1,161
August	6,665	7,580	256,427	3,858	151,912	290	35,292	1,621	133,675	1,090	45,480	756	1,155
September	6,731	7,483	256,269	3,784	150,194	279	36,361	1,621	143,248	1,061	46,267	829	1,218
October	6,837	7,465	267,346	3,827	153,103	309	36,705	1,612	152,288	1,123	47,040	821	1,206
November	7,014	7,692	260,707	3,867	157,871	341	33,283	1,680	141,808	1,214	44,071	823	1,322
December	7,155	7,762	265,610	3,916	165,433	395	26,770	1,765	111,333	1,286	39,174	884	1,502
1956:													
January	7,199	8,023	261,592	3,927	183,905	385	21,310	1,923	86,141	1,344	38,247	805	1,422
February	7,208	8,047	259,504	3,854	196,092	385	18,712	1,918	71,335	1,286	35,673	878	1,472
March	7,278	7,914	265,683	3,829	199,698	342	17,215	1,808	60,846	1,213	32,984	934	1,425
April	7,146	7,487	277,121	3,646	193,299	299	18,227	1,713	63,571	1,130	32,740	815	1,305
May	7,064	7,896	277,497	3,859	186,673	292	21,883	1,667	75,928	1,149	36,607	938	1,416
June	7,045	8,048	274,677	3,906	180,729	294	26,059	1,751	94,993	1,115	38,776	976	1,371
July	7,088	8,011	277,546	3,895	177,416	300	29,400	1,808	117,664	1,105	44,189	1,081	1,408
Week Ended:													
8–17–56	7,122	7,899	277,065	3,910	176,202	324	30,717	1,812	128,934	1,128	44,996	986	1,325
8–19–55	6,701	7,505	262,469	3,816	155,563	311	33,557	1,565	125,222	1,116	46,349	732	1,041

Source: Data for last two months from API; prior monthly data from Bureau of Mines. Data in thousands of barrels.



Lummus, Aramco teamwork supplies more quality gasoline from Saudi Arabia

In August at Ras Tanura, Saudi Arabia, a 12,500 B/D Fluid Hydroformer is undergoing its first turnaround since it came on stream in October, 1955. For the past 10 months this unit has supplied 92.5 F-1 clear octane blending stock to European and Middle East markets, where the need for quality gasoline is growing rapidly.

The Hydroformer was designed and engineered by Lummus for The Arabian American Oil Company under license from Esso Research and Engineering Co. The process, though more complex than any other in the Ras Tanura Refinery, was designed for ease of operation to fit in with the Company's policy of training and upgrading Saudi Arab nationals to the fullest extent.

Close liaison among the three groups during all phases of design and construction has paid off. Startup was smooth, with all facilities operating at full design rate soon after feed was introduced. And the plant has been operating successfully ever since, at and above the design rate. In all cases, hydroformates of premium quality have been obtained from the high paraffin – low naphthene stocks characteristic of Arabian crudes.

Test runs at feed rates of 12,500 – 16,300 B/D have yielded products of 94.8 – 87.4 F-1 clear octane. There has been no difficulty in making the 92.5 octane design product at rates up to about 13,500 B/D. These tests indicate that hydroformates close to 95 F-1 clear can be produced in good yields, and should higher quality be needed, more severe hydroforming conditions appear to be feasible.

Aramco's new Hydroformer is one of over 700 major Lummus installations throughout the world. The excellent operating record of this new unit, and of Lummus plants in general, proves the case for coordinated direction of a project from idea to startup. Lummus teamwork can pay off on your next project.

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On Organic Chemistry

ORGANIC CHEMISTRY is the subject of a revised book reviewed this month. Now in its third edition, this book develops the principles and concepts of modern organic chemistry and the application of this science to technology.

Keep Going to Page 350

Is There a Doctor?

EVER THINK of surgeon's clamps to speed up electrical work? One plant did, and the Maintenance Department found them to be a great aid in making soldered connections. Details on this and other helpful hints appear in "How to Do It."

Keep Going to Page 357

At a High Pitch

THE TONE OF ACTIVITY in Japan's Petroleum-refining and petrochemical industries—already vastly increased since World War II—now has been further intensified by announcements that three more contracts have been awarded for construction of new petroleum-processing facilities: a new refinery will be constructed on the site of the former Japanese naval depot at Tokuyama; the first Houdriformer in the Far East will be installed at Yokkaichi, and at Iwakuni City, construction has started on the Orient's first phenol plant. Details of these new developments are covered in "Who's Building."

Keep Going to Page 373

Of General Interest

IN ADDITION to its regular article on postwar construction and modernization, "As Management Sees It" this month presents three other articles of interest to everyone in the industry. They deal with safety; take up the subject of how to streamline office work, and consider the advantages of suggestion systems.

Keep Going to Page 402

Harnessing the Atom

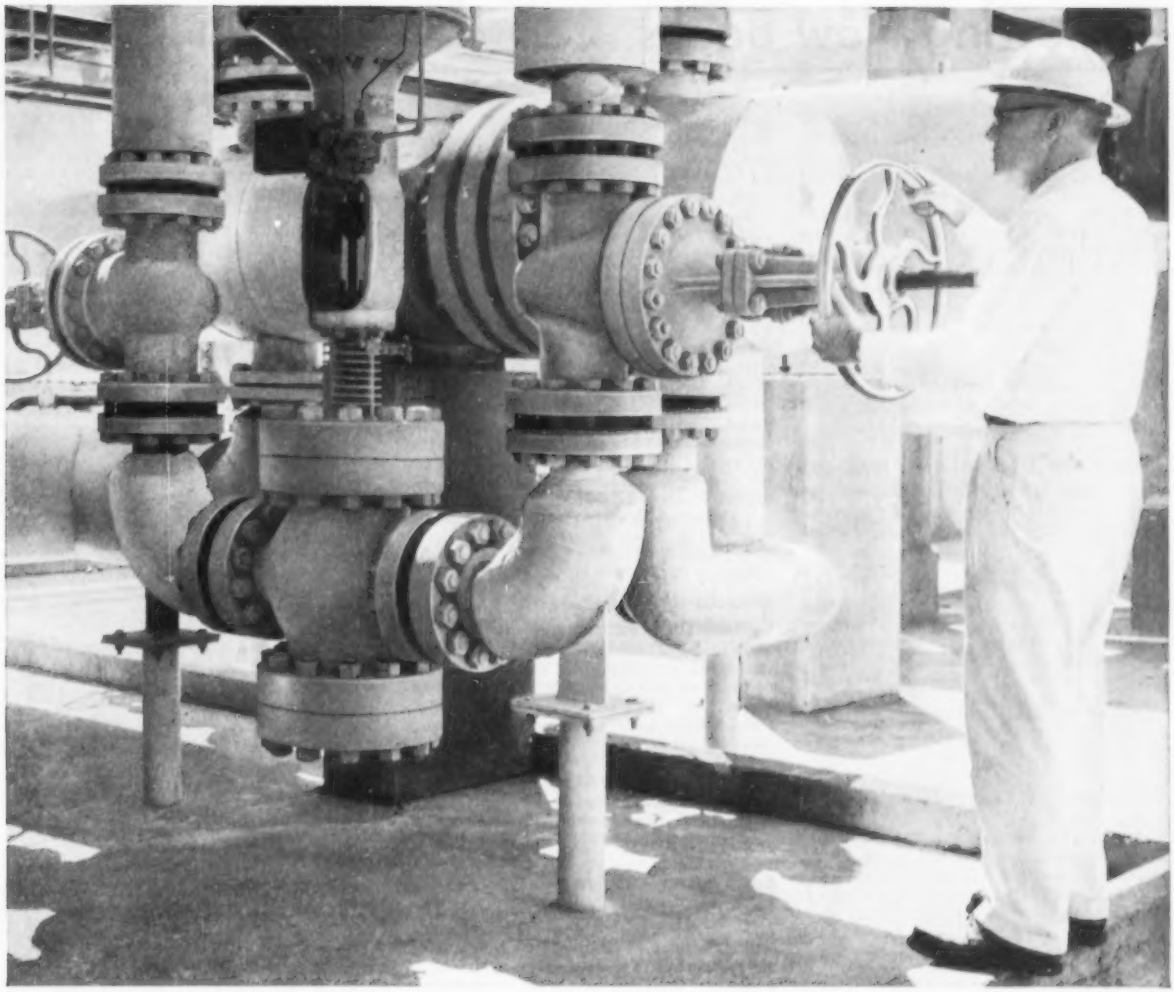
A MINIATURE REFINERY has been installed in the atomic pile at Brookhaven National Laboratory. Operated by one of the pioneers in the study of the effects of radiation on petroleum refining, this new unit permits a continuous flow of petroleum samples through the pile, simulating actual refining conditions under the influence of atomic radiation. For a report on The Atlantic Refining Company's latest effort to harness the atom for refiners, see "What's Happening in Industry."

Keep Going to Page 437

A New Gas Turbine

AMONG THE ITEMS taken up in "What's New in Equipment" is a gas turbine which is now being imported from England. This prime mover is especially suited for processes which require power and use exhaust energy for preheating or generating steam.

Keep Going to Page 508



This Crane valve tight and trouble-free after 3 years on severe reboiler service

Here's the kind of valve performance every refinery would like to be getting.

When Delhi-Taylor Oil Corp. built the U.O.P. platformer unit in their Texas refinery in 1953, they installed this Crane 8-inch No. 83X 900-pound steel valve on the lines to the reboiler. The valve—a wedge gate type—handles platformates mixed with hydrogen gas at 550 psi. and 900° F.

What's the story on this Crane valve after 3 years on this extra-severe service? No maintenance of any kind—and it's closing just as tight and sure as it did the day it went on the line.

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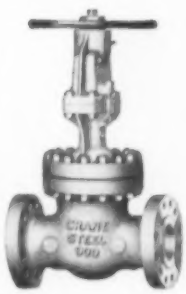

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Reviewing New Books . . .

Organic Chemistry, Third Edition, by Louis F. and Mary Fieser. Completely revised, this book develops the principles and concepts of modern organic chemistry and the application of the science to technology. Since the second edition was published in 1949, a number of new developments have been made in this important field. Some of those which are taken up in this third edition are not covered in any other book. Advances in theory also have been striking, and these have been included in the new edition.

(Reinhold Publishing Corporation, 430 Park Avenue, New York 22, 1112 pages, $10. For sale by Gulf Publishing Company, P. O. Box 2608, Houston.)

Hydrogen Peroxide Physical Properties Data Book, prepared by Food Machinery and Chemical Corporation. This 1955 edition presents recommended values of all physical properties of hydrogen peroxide which have been reported in technical literature to date. In the six years since the first edition was published, more than 50 pages on the physical properties of hydrogen peroxide have appeared in literature. As a result, less than 10 percent of the data in this book has survived from the 1949 edition.

(Becco Chemical Division, Food Machinery and Chemical Corporation, Buffalo 7, N. Y., $1.)

Properties of Combustion Gases, prepared by the Aircraft Gas Turbine Development department of General Electric Company. Composed wholly of tables with brief introductory text, these two volumes provide an accurate knowledge of the thermodynamic properties and behavior of the working fluid of combustion engines under a wide range of operating conditions.

They are primarily aimed at providing basic information for gas turbine engineering, especially cycle calculations; the data, however, are pertinent and applicable to many general areas, e.g., dynamics of compressible flow, fundamental combustion research, etc. Procedures are developed for applying the tabulated data to a number of frequently encountered engineering problems: determination of adiabatic flame temperatures, theoretical heat releases, combustion in a constant area duct and isentropic expansions (on both equilibrium and "frozen" composition bases). Several problems and their numerical solutions are included to illustrate these methods.

Volume I, Thermodynamic Properties, contains 45 pages of introductory material and lists in English units, the function: enthalpy, entropy, mean molecular weight, density, sonic velocity (on both equilibrium and frozen composition bases), heat capacity and two non-ideality coefficients.

Volume II, Chemical Composition of Equilibrium Mixtures, lists the equilibrium chemical composition of the combustion gases in terms of the molfractions for temperatures above 2500 R. All molfractions greater than 10^{-9} are listed. In addition, this volume contains tabulations of the enthalpy, Gibbs free energy, entropy and heat capacity functions of 14 pure species.

(McGraw-Hill, 327 West 41st Street, New York 36, 1038 pages, $75.)

Standards on Electrical Insulating Materials, prepared by the American Society for Testing Materials' Committee on Electrical Insulating Materials. This latest edition of the compilation of standards includes specifications and test methods covering various types of materials in this field. The changes since the previous edition issued in 1955 comprise 12 revisions and two new items covering methods of testing silicone insulating varnishes and a recommended practice for cleaning plastic specimens for insulation resistance testing. The compilation includes 83 methods of test and specifications.

Two appendices, give proposed recommendations for writing statements on the usefulness of tests of electrical insulating materials, and proposed methods of test for dielectric constant and dissipation factor of aviation fuels.

(American Society for Testing Materials, 1916 Race Street, Philadelphia 3, 656 Pages, $6.)

Standards on Metallic Electrical Conductors, prepared by the American Society for Testing Materials. All ASTM standards pertaining to metallic electric conductors and related standards are included in this compact, readily-usable form. Of the material covered in this compilation, 20 of the specifications have been revised and one of the standards is new since the previous edition.

(American Society for Testing Materials, 1916 Race Street, Philadelphia 3, 300 pages, $3.50.)

Equilibrium Moisture Content of Natural Gases, by R. F. Bukacek. This bulletin describes laboratory equipment, and experimental techniques, experimental measurements of the moisture contents of methane, propane, nitrogen, a methane-propane mixture, two methane-butane mixtures, a methane-pentane mixture and two natural gases at 220 F and in the pressure range 1000-10,000 pounds per square inch. It also shows a newly-developed correlation for computing the equilibrium moisture contents of natural gases.

The experimental data show the composition of a gaseous hydrocarbon mixture may be a factor in determining its equilibrium moisture content where the concentration of heavy hydrocarbons is high, or the equilibrium temperature is near or below the mixture's critical temperature. The correlation of equilibrium moisture contents is applicable to natural gases at the temperatures below the critical. Within experimental error, the moisture content data on natural gases, methane and methane-ethane mixtures are well represented by correlation.

(Institute of Gas Technology, Technology Center, Chicago 16, 20 pages, $3.)

Tough Enough to Grow, by Vernon H. Van Diver. This little book is the story of Arapahoe Chemicals, Inc., and its affiliated Arapahoe Special Products, Inc. The books follows pretty much the formulae of other publications designed to provide information about companies soliciting opportunities in contract manufacturing.

(Arapahoe Chemicals, Inc., Boulder, Colo., 56 pages, free on request.)

The Petroleum Refinery Engineer's Handbook, by J. F. Strachan. This book, which essentially is a second edition of the author's *Practical Inspection of Oil Refinery Equipment,* was written for the refinery inspector. It discusses the most recent methods of inspection and recording used in refineries, takes up a general discussion of refinery equipment, covers materials of construction and operating conditions to suggest frequency of inspections, and illustrates all aspects of plant corrosion and protective measures.

(Philosophical Library, Inc., 15 East 40th Street, New York 16, 168 pages, $15. For sale by Gulf Publishing Company, P. O. Box 2608, Houston.)

Development of Standards for Evaluating Vegetable Damage Caused by Air Pollution, prepared by Stanford Research Institute. This four-volume index contains 200 color transparencies of ten common U. S. weeds that react to various kinds of air pollutants.

The 4 x 5-inch transparencies are mounted against a white background with descriptive text on facing pages; they are completely cross-indexed by volume number, weed and fumigant. The information also is available in a collection of 2 x 2-inch individual slides which are described in a bound supplement.

(Industrial Air Pollution Research Station, Stanford Research Institute, Menlo Park, Calif., $2400 and $2170, respectively.)

Corrosion in Engine Cooling System Containing Aluminum: A Literature Survey, by Mildred Bention. This survey of the literature on corrosion was compiled by the Naval Research Laboratory. The bibliography cites sources available from 1926 through June, 1955.

Compilation of this reference source was prompted by research in cooling aluminum-containing structures such as aircraft engines. NRL is also interested in source material on inhibitors in such systems. The study lists 119 works that bear on this subject. Each listing is abstracted.

(Office of Technical Services, Department of Commerce, Washington 25, D. C., 31 pages, $1.)

Data Sheets on Fuels and Lubricants, prepared by the Royal Aeronautical Society and the Institute of Petroleum. The aim of these sheets is to provide convenient information on the physical and chemical properties of aviation fuels and lubricants. The scope of the information required and its presentation in data sheets was the responsibility of the Royal Aeronautical Society's Fuels and Oils committee; collecting and analyzing the data was done by the Aviation Products committee of the Institute of Petroleum.

(The Royal Aeronautical Society, 4 Hamilton Place, London, W1, England, 32 data sheets, $17.16.)

Polyesters and Their Applications, by Johan Bjorksten, Henry Tovey, Betty Harker and James Henning. This book is the first comprehensive survey of the entire polyester field from raw materials to finished product. The text and annotated bibliography of more than 3300 references cover most phases of the production and uses of polyesters. This includes patents and literature on any particular phase of the polyester field. Included are not only the unsaturated polyesters used in molding, casting, coating, impregnating and

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New Books . . .

laminating, but also the saturated polyesters used in the production of fibers, films, elastomers and foamed plastics.

(Reinhold Publishing Corporation, 430 Park Avenue, New York 22, 618 pages, $10. For sale by Gulf Publishing Company, P. O. Box 2608, Houston.)

National Survey of Burner Fuel Oils, 1956. A study of burner-fuel oils is given in this report recently issued by the Bureau of Mines. The survey was conducted at the request of the Oil-Heat Institute of America, Inc., and the petroleum industry, under a cooperative agreement between the bureau and the American Petroleum Institute. It is the second such survey reported.

Under the cooperative agreement, samples of burner-fuel oil, typical of their manufacture during the early part of 1956, were analyzed by the refiners and the results were transmitted to the bureau for study and compilation. Data on 427 samples were submitted by 45 petroleum refining companies.

The report presents the data in tabular form, giving the analyses in detail in five general groups according to the grade of burner-fuel oil; each group is subdivided into five tabulations according to the geographic marketing distribution of the fuels. A map in the report indicates the five regions and, by capital letters, the 14 districts which these regions comprise.

Summaries of the results of the survey compared with summarized data from the 1955 survey report, are shown in tables 1 through 5.

(Bureau of Mines, Interior Department, Washington.)

Testing Mass Standards by Substitution, a National Bureau of Standards film. Produced at the request of the National Conference on Weights and Measures, this film presents recommended procedures for testing mass standards by substitute weighing. It demonstrates a simple method for quickly determining with a high degree of precision the mass of an "unknown" standard by comparison with one of a known value. This is known as "error testing." Also demonstrated is the technique of "tolerance testing," a simpler procedure used to determine whether or not the error of a standard is within certain prescribed limits.

(Office of Technical Information, National Bureau of Standards, Washington 25, 16mm, color and sound, 22 minutes. Information about purchasing or borrowing the film will be furnished.)

Intermediate for Flame-Resistant Polymers, by **Wilson A. Reeves** and **John D. Guthrie.** Flame- and glow-resistant resins can be made by substituting tetrakis (hydroxymethyl) phosphonium chloride for the compounds commonly used to polymerize phenols, amines, and carboxylic acids. Materials of these three groups are widely used for the preparation of resins for the manufacture of molded objects, paints, and other products, but one of the disadvantages for many purposes has been the fact that the resulting "plastics" will burn.

Research on the polymerization of various compounds with tetrakis (hydroxymethyl) phosphonium chloride was

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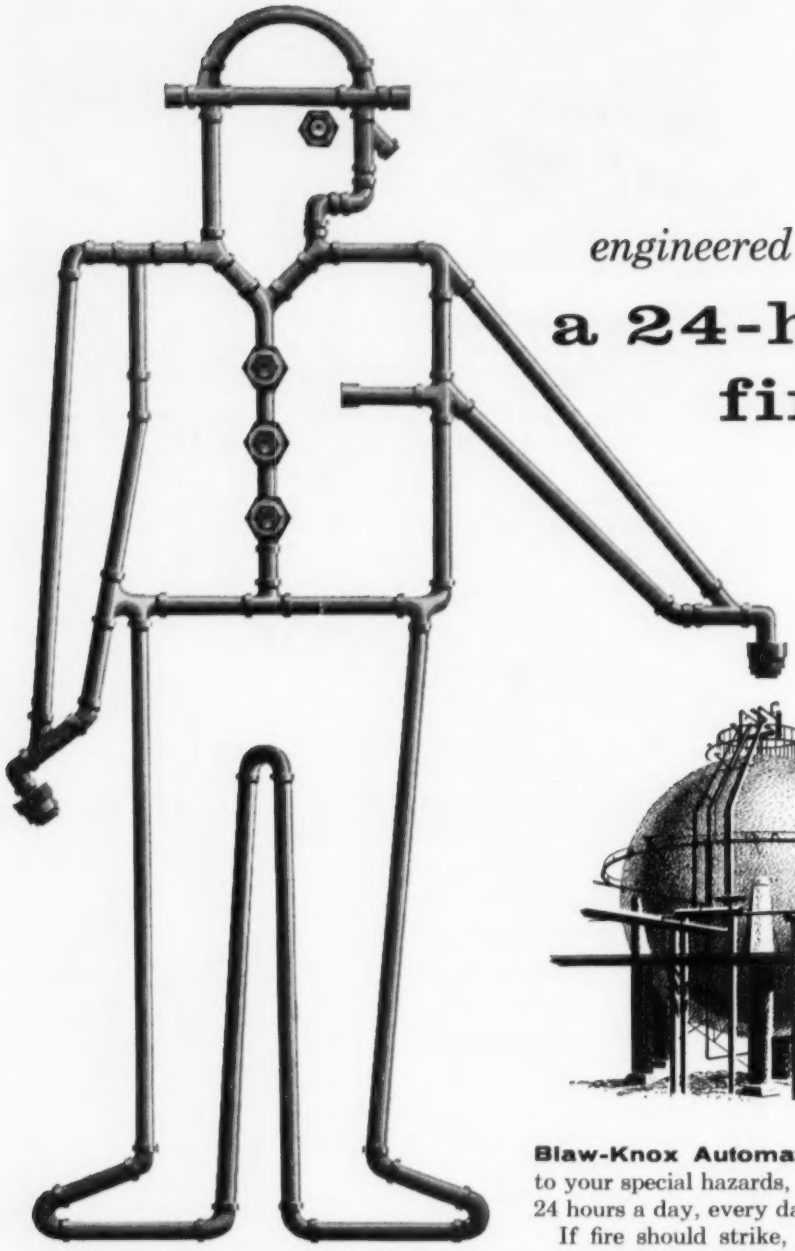

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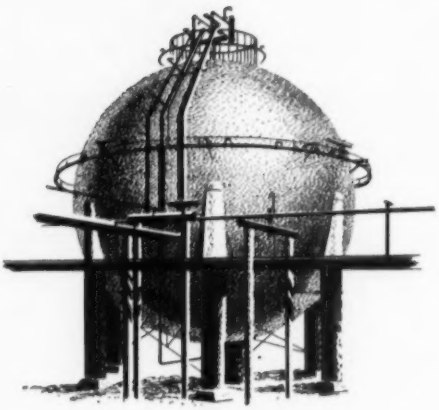

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New Books . . .

carried out by the authors at the Southern Utilization Research Branch of the Agricultural Research Service. THPC, which has been found quite effective as a flame-retardant treatment for cotton, also gave satisfactory results when substituted for the usual polymerizing agents in the preparation of resins, and imparted desirable flame-resistant qualities to the products. Reactions of THPC with cetylamine, urea, melamine, ethylenimine, phenol, phloroglucinol, and chlorendic anhydride are reported, and the chemistry and results of the reactions discussed.

(Southern Utilization Research Branch, Agriculture Department, 1100 Robert E. Lee Boulevard, New Orleans 19. Free of charge).

Smoley's Tables. These mathematical tables are timesavers for engineers, designers and builders. The new edition is enlarged and revised. The tables are in four separate books or in combinations of three and four.

(C. K. Smoley & Sons, Inc., P. O. Box 14, Chautauqua, N. Y., Slopes & Rises, 384 pages, $6; Logs and Squares, $6; Logarithmic and Trigometric Tables, $1.50; Segmental Functions, $5; Three Combined Tables, $10, Four Combined Tables, $12.)

Systems Engineering, by **J. N. Warfield.** This report was prepared at Pennsylvania State University for use by the Navy. The author defines a systems engineer as a man who, when assigned to a project, is capable of coordinating and preparing or carrying out three things:

- An optimum system (system survey) showing the interrelation of all factors that will affect the project and sway future action.
- An optimum set of organized ideas (the plan of procedure) pertaining to carrying out the project.
- An optimum physical realization (the product) of the devices necessary to terminate the project.

To provide useful material for the systems engineer in any industry, technical considerations are eliminated and only material common to most systems problems is included in the book. An introduction to systems engineering is given, the factors surrounding a typical systems-engineering problem are enumerated, and the systems design process is outlined.

The system survey, a preliminary step in the systems-engineering process, and the organized project plan are discussed, and a check list is given for each. Ideal and optimum tests are defined. Based on the development cycle, product development is examined from the systems-engineering viewpoint, and the subject of system tests is treated, with a check list given. The report concludes with a discussion of the completion and reinstigation of projects.

(Office of Technical Services, Commerce Department, Washington 25, 30 pages, 75 cents.)

Standards for the Storage and Handling of Liquefied Petroleum Gases. This revised standard has been adopted by the National Fire Protection Association. It is now available in pamphlet form.

(National Fire Protection Association, 60 Batterymarch Street, Boston 10, 80 pages, 35 cents.)

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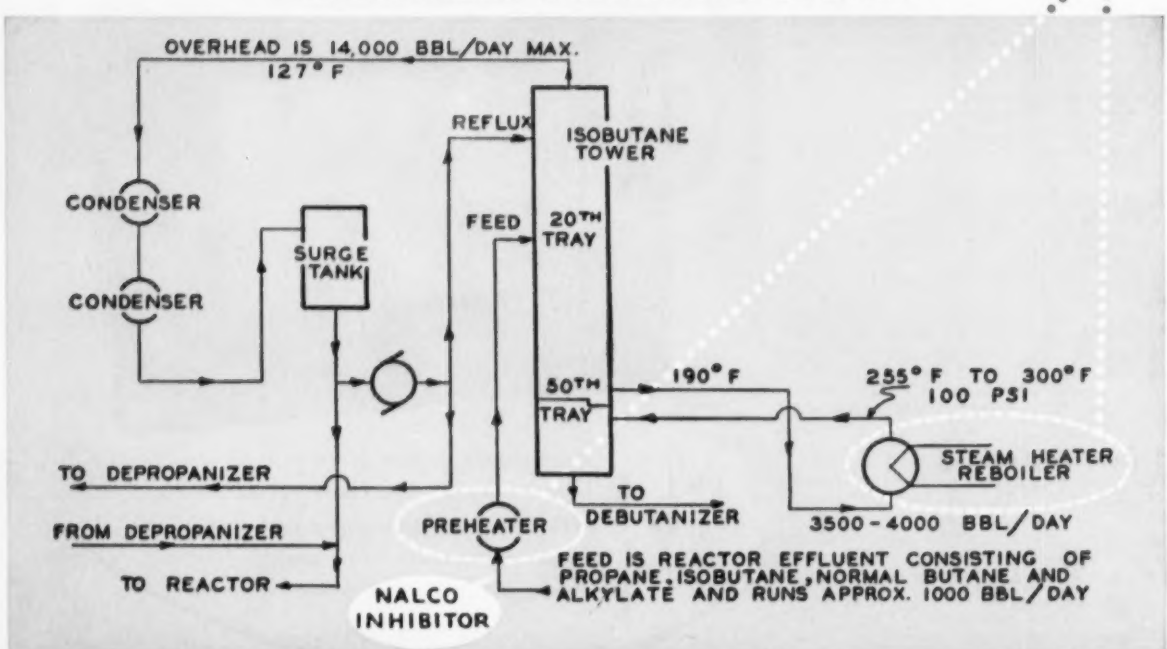

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Controlled Tube Rolling Reduces Repairs

HIGH STEAM pressures used today require a precise method of controlling tube expansion. When the use of low-steam pressure was prevalent, the condition of over-rolled tubes was not as serious as it is now, since the maximum physical limits of metals were not actually reached. Working with low pressures, operators got satisfactory joints by depending on expander resistance or the feel or sound of the motor.

A precise control for tube expanding should do the following: (1) prevent over-rolling; (2) provide uniform, tight joints, regardless of tube-sheet-hole variation; (3) prevent destruction caused through cold-working of the metal; (4) prevent excessively-thinned tube ends with the probability of subsequent "leakers;" (5) prevent overstressing of tube sheets to minimize warpage and ligament "push-over;" (6) cause minimum axial pressure against tube sheets for greater tube life; and (7) minimize bowing of the tubes so that heat transfer rates remain high.

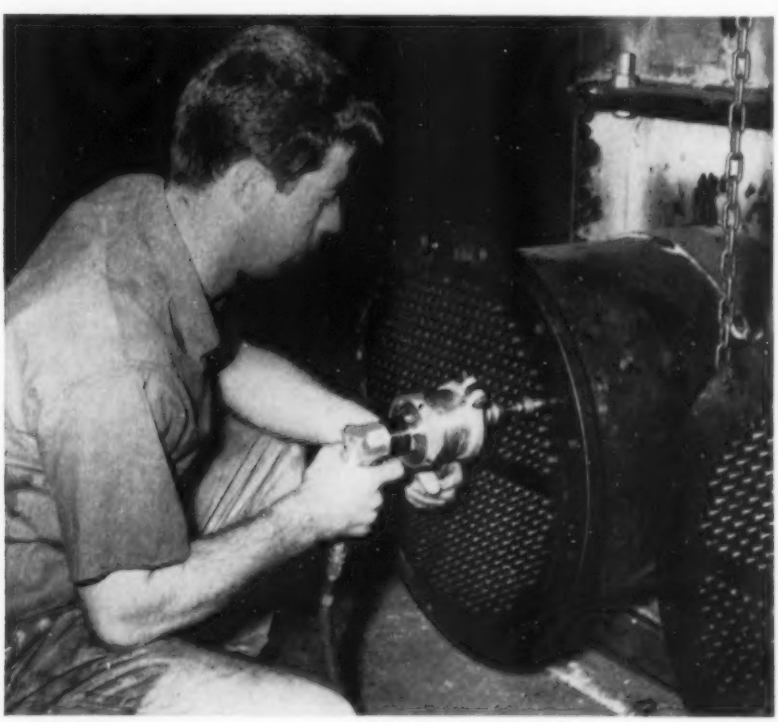
There are several types of units available for controlling tube expansion. These controls may rely on auxiliary generators, vacuum tubes, solenoid valves, pumps, switches, or other equipment. One simple device, recently introduced, uses an air drive, which controls tube expansion by measuring torque output directly at the mandrel.

"Optimum" and "Adequate" Joints—An "optimum" joint exists when pressures are held without leakage, and a tube has been rolled or expanded just short of its extreme cold-working point, where crystallization begins. Although an "optimum" joint may be desired from a laboratory viewpoint, 90 percent of the time an "adequate" joint will serve the purpose.

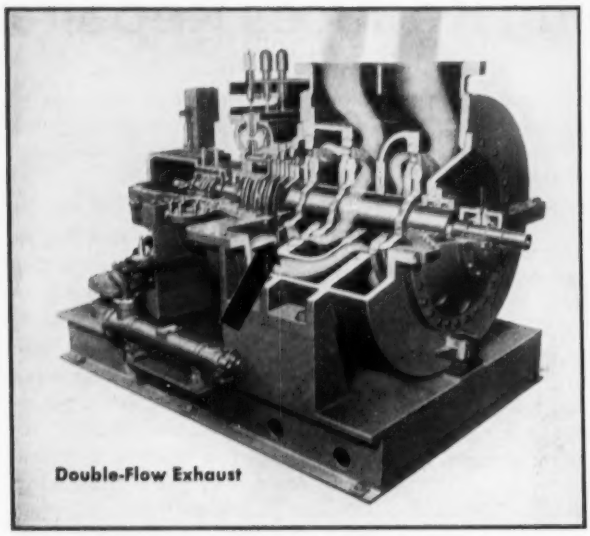
The operating engineer usually knows what extent of expansion or tube-wall reduction has given him satisfactory performance. The expansion control should allow relatively untrained personnel to make both optimum and adequate joints regularly. It should also minimize operator concentration; the resulting reduced fatigue will improve the work.

The amount of wall reduction (thinning of original tube wall when expanded) depends on tube size, pressure, and type of service. It may range from 3 percent to over 6 percent. Extensive experimentation has established that the most reliable method to determine the effectiveness of a joint is to measure the displacement of the metal after metal-to-metal contact of the tube wall with the tube seat has been made. There are two ways to measure the displacement: (1) by the amount the tube is extruded out of the tube sheet; and (2) by the increase in diameter of the tube. The latter method is easiest to use.

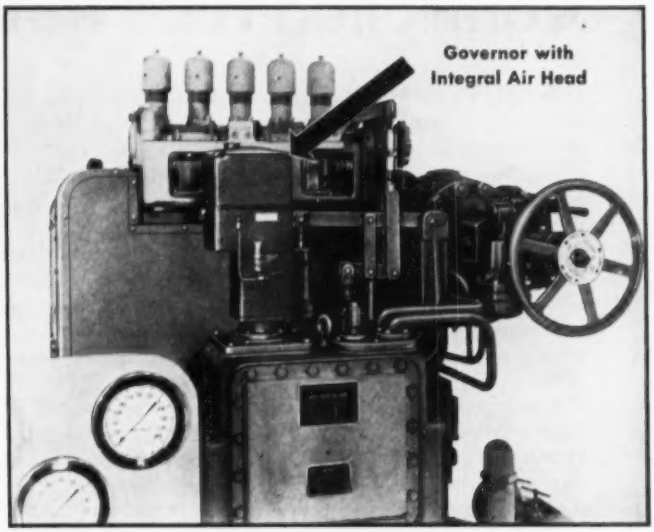
Here's how to determine the desired expanded diameter of a tube. It is first necessary to ascertain the clearance between the tube and tube hole. Measuring the outside diameter of the tube and subtracting it from the diameter of the tube hole gives this result. The inside diameter of the tube is added to this figure, which represents the inside diameter at metal-to-metal contact. Next, the amount of reduction in the tube wall should be added. (The amount of tube-wall reduction generally considered most desirable for the average non-ferrous heat exchanger application is approximately 4 to 5 percent. The calculation for tube-wall reduc-



In high-speed turbines . . . why does in total horsepower and



GREATER RELIABILITY. Worthington's rugged construction pays off in extra reliability. Solid rotor for modern high speeds, double-flow exhaust where large volumes of steam are used in condensing operation, and Kingsbury type thrust bearings are just a few of the features that assure safety and dependable service on your vital compressor and blower drives.



ACCURATE SPEED REGULATION. Exclusive Worthington governing system using governor with integral air motor gives you speed control response to .04 psi change in control pressure. And it provides for remote automatic operation if you need it. The oil relay type governor so equipped instantaneously controls pressure or volume delivered by the compressor regardless of steam variations.

Where turbine-driven compressors and blowers are used, down-time is usually mighty expensive. Particularly so if failure can bring a continuous process to a standstill. In the case of high-speed/high-horsepower compressor-drive turbines, your surest way to design reliability into your plant is to specify the turbine line with best *proven* performance.

Compressor-drive turbine installations up to 12,000 rpm, and 24,000 hp, show Worthington leads in application engineering, design, reliability.

Worthington compressor-drive turbines are conservatively built with all stresses carefully calculated and kept well within established safety margins. Also, measured load tests are performed on every unit at the factory with modern facilities, under the watchful eyes of highly trained personnel.

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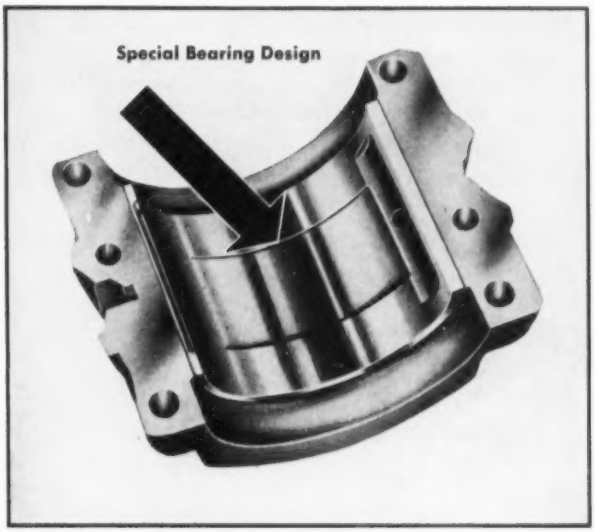

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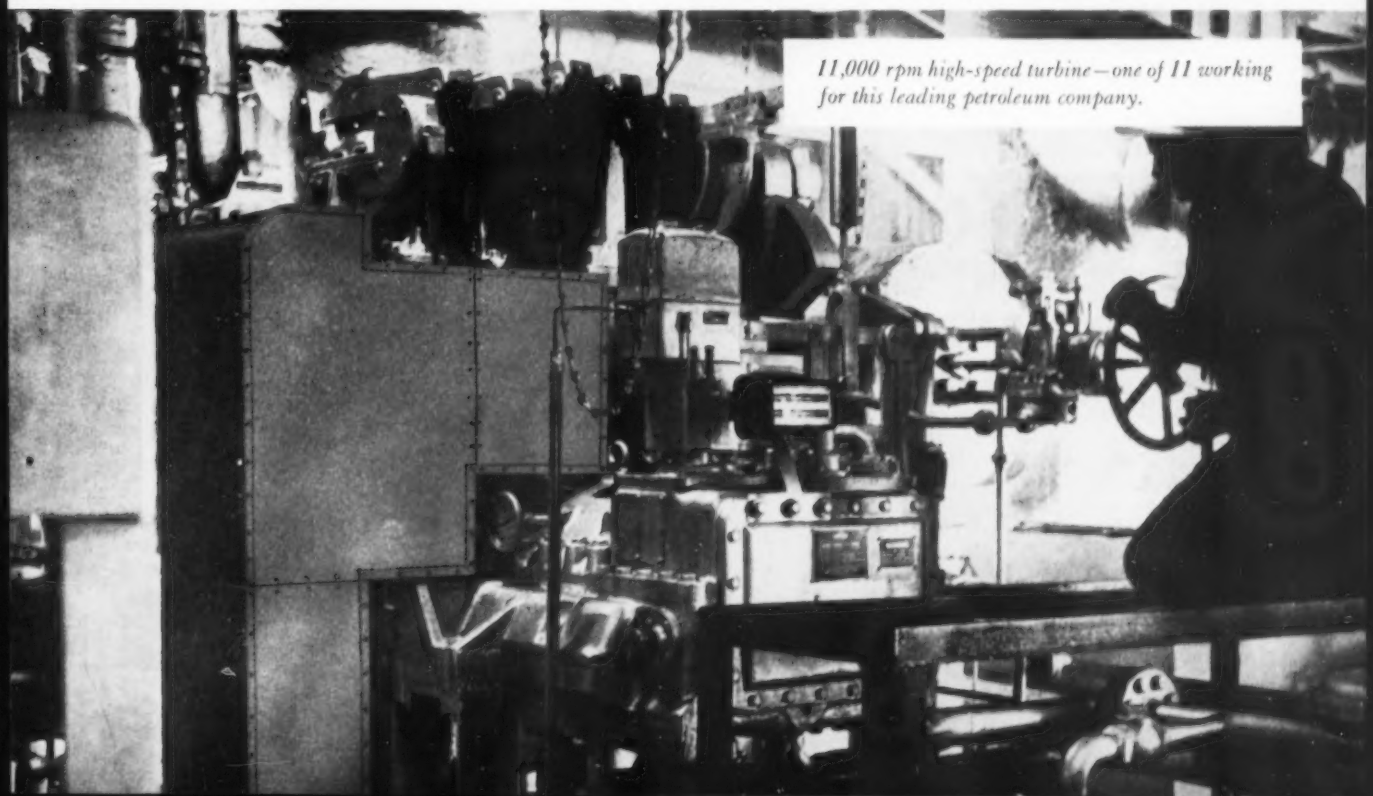
Main Bearings	Anti oil-whip—for longer turbine life.	✓			
Thrust Bearing	Kingsbury type—for proven reliability.	✓			
Automatic Nozzle Control	Cam operated—for economy and better control.	✓			
Governor	Has integral air motor—for more accurate control.	✓			
Type Construction	Double flow exhaust for economy and long life.	✓			
Packing	Labyrinth—for most effective seal at high speed.	✓			
Test	Load test—to be sure you get what you ordered.	✓			

LOWER MAINTENANCE COST. One important example of construction used to help eliminate non-scheduled maintenance is Worthington's anti oil-whip bearing. During operation a pocket (arrow) in the upper half of the bearing builds up a pressure pad of oil. High pressure here creates a downward force on the journal, holding it in place in the bearing, preventing destructive vibration.

LONGER LIFE. A long, trouble-free life can be attributed to no *one* turbine feature, but rather a combination of many engineering advances. Compare design features yourself, one by one. Far ahead of any other manufacturer in the compressor-drive field, Worthington's first compressor-drive turbine built in 1927 is still working around the clock, in a large Eastern gas plant.



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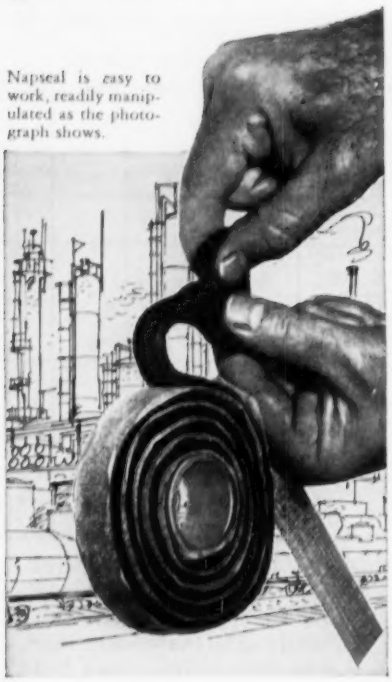

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Johns-Manville
SEALING COMPOUNDS

How to Do It...

tion should take into consideration that two walls make up the diameter of the tube. The resulting figure is the desired expanded inside diameter of the tube.

An example of how to determine the desired expanded diameter for a ¾-inch x 18-gauge (.049-inch) tube is as follows:

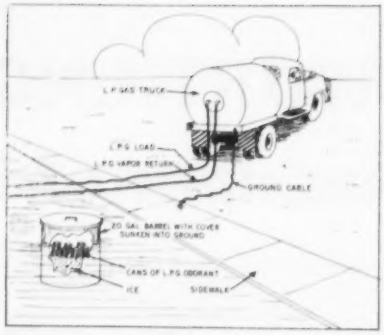
.756 Tube sheet hole
—.750 Tube O.D.
= .006 Clearance
+ .652 Tube I.D.
= .658 Tube I.D. at metal-to-metal contact
+ .004 Increase in I.D. to compensate for 4% tube wall reduction (4% x .049 x 2 walls).
= .662 Desired expanded inside diameter

Dissolve Chemicals Faster

This is one way to step up the job of dissolving chemicals before they are used in a chemical feeder.

Here, a clean, 55-gallon drum with the top third cut off is used as a mixer. A perforated, 5-gallon paint bucket is filled with the chemicals, and suspended in the drum by fasting the bale to the top of the drum.

The drum is filled with water to a level just below the bucket, and air is admitted. When the chemicals are dissolved, the mixture is transferred to the feeder.



Ice Reduces Odor

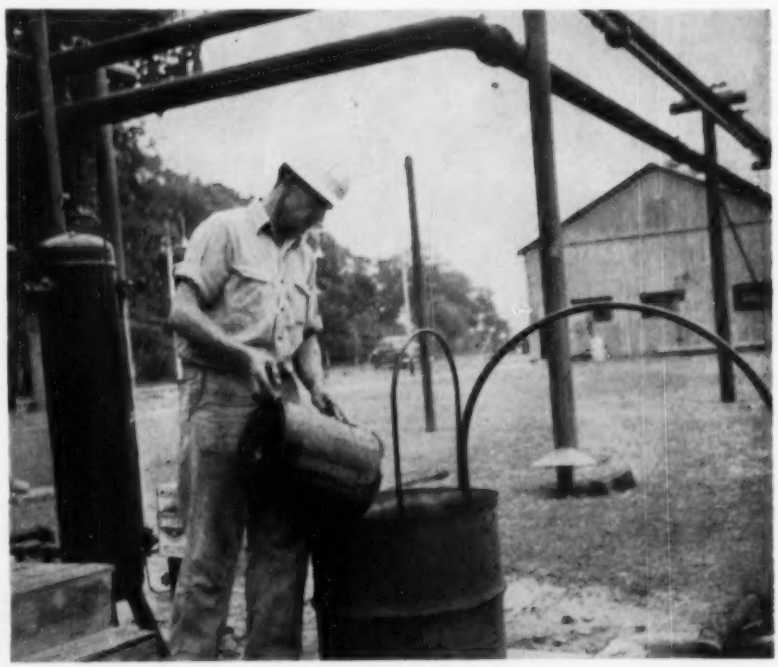
Odorants poured into LPG truck-loading hoses vaporize much more readily during the hot summer months. This results in an unpleasant atmosphere and may pollute the clothes of the men operating the loading facilities.

The vapor pressure and correspondingly the olfactory effect can be reduced by keeping the cans of odorant in a container filled with ice. The cold, liquid odorant, when poured into the loading hose, will not have time to vaporize.

Anchor Down Hoses

Sometimes the valve on the wrong hose at a loading rack is opened by accident. When this happens the hose may whip about violently unless anchored in some manner.

An efficient and inexpensive an-



Why spend time cutting and fitting small pieces of rigid insulation . . . when you can **WRAP YOUR TANKS WITH EFFICIENT ULTRALITE AND REAP THE SAVINGS?**

NO CRACKING under expansion and contraction, for **ULTRALITE** is flexible and *permanent*. No expansion joints . . . no pointing up.

A candid look at a new concept in tank insulation

These photos explain why **ULTRALITE,** the long glass fiber insulation in rolls, is rapidly becoming **THE** insulation for tanks and vessels of all kinds. For "How-to-do-it" specifications and immediate delivery, consult the Yellow Pages under "Gustin-Bacon Insulations" and call your local **ULTRALITE** distributor in any of 67 cities, or . . .

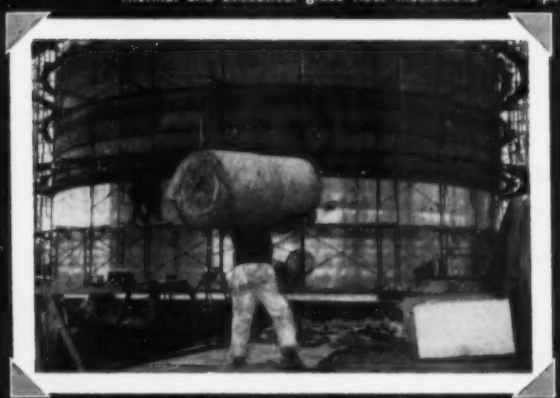
WRITE TODAY FOR TECHNICAL INFORMATION

GUSTIN-BACON *Manufacturing Company*

GUSTIN gb BACON

210 W. 10th • Kansas City, Mo.

Thermal and acoustical glass fiber insulations • Pipe couplings and fittings • Molded glass fiber pipe insulation



Lightweight **ULTRALITE** comes in rolls up to **10 FT. WIDE,** in thicknesses up to 6 in. and densities up to 3 lbs. per cubic foot. Thermal efficiency?—Average K factor is .27 at 70° mean temperature.

The bigger the tank, the bigger the saving—but don't overlook the economy of **ULTRALITE** on *all* tanks, vats and vessels!

Whether you run **ULTRALITE** up and down, or round and round, you only need **HALF** as many fasteners to hold **ULTRALITE** firmly in place.

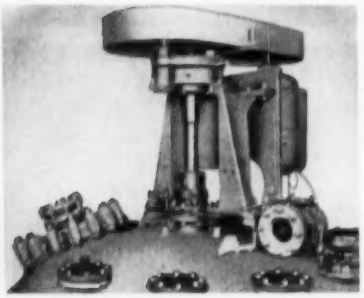
ULTRALITE can be weatherproofed with any of the customary materials. On towers wrapped with **ULTRALITE,** weatherproofing materials are often sprayed on reinforcing membranes such as mesh screen and glass fabric.

EXTRA FAST DELIVERY
of standard Pfaudler glassed reactors now!

Pfaudler

Pfaudler Corrosioneering News Published by The Pfaudler Co., Rochester, N.Y.

ANNOUNCING PFAUDLER'S NEW



With Pfaudler's standard glassed steel polymerizers...

NO NEED TO SPEND OR TO WAIT FOR SPECIAL DESIGNS

Pfaudler now offers you four standard reactors—engineered to give you adaptability to a wide range of services.

Experience in the engineering of all types of polymerizers has led Pfaudler to incorporate the *best* features in standard designs. You can now save money by ordering a 2000- or 3700-gallon reactor rated for either 150 or 200 psi and get faster delivery than you could hope for with special designs.

You benefit in many ways when you install a standard glassed steel reactor:

Assures purity

Since resins will generally tolerate *no* contamination, all surfaces in contact with the product are nonmetallic – almost entirely glassed steel. Glass *cannot* discolor products or act as a catalyst to inhibit polymerization! Accordingly it improves purity, uniformity, and yields.

Easy to clean

Synthetic resins, which may cling to even highly polished metals, usually will not adhere to the smooth, hard surface of glass. Cleaning, then, is simple and fast – Pfaudler's new Spray Rinse Valve does it thoroughly without opening the vessel. The agitator speeds emptying through the off-center bottom outlet. The outlet valve has a spray ring for cleaning this point.

Money saving feature

Glassed steel is a less costly material of construction than alloys. The saving is especially significant when high pressure construction is required. Furthermore, expense and delay in special designing are avoided.

Easy to operate

Pfaudler's new demountable blade agitator has made possible a series of design improvements which result in more convenient operation of the vessel. The blades can be removed without disturbing the drive. Need for a large cover has been eliminated. Accordingly, the manhole has been made larger and moved nearer to the side. The position of nozzles in the top head is likewise more convenient.

Sensitive temperature control

Each standard vessel has been designed for rapid flow on both sides of the heat transfer surfaces. This and several other features make possible temperature control within ±1.0° F.

The Pfaudler agitative system furthermore produces thorough mixing—*and has been specifically designed to give uniform resin particle size.*

Pfaudler manufactures a variety of corrosion-resistant reactors, of course, as well as other equipment widely used in producing resins. If your process requires special engineering, Pfaudler can help you. But before you spend and wait for a special design, check to see if one of Pfaudler's *standard* polymerizers won't give you the adaptability you need.

Drop us a line and get more information about these standard reactors. Ask for Bulletin 932.

A new glassed steel autoclave

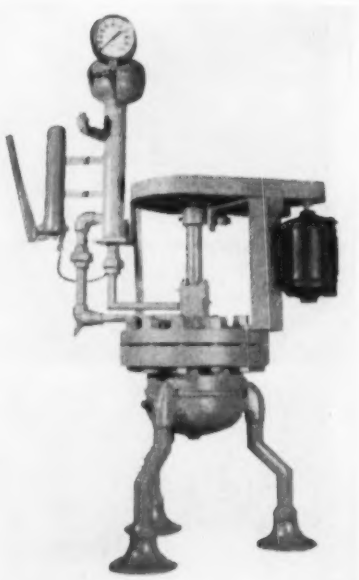
Handles reactions up to 750 psi

Your experiments with reactions involving high pressure and corrosive liquids have led to the development of a new, specially designed autoclave – now available to you at Pfaudler.

The new autoclave permits you to conduct reactions where internal pressures go as high as 750 psi with complete safety. Glassed steel construction prevents any undesired catalysis in the product from occurring. And you can study the reaction of highly corrosive liquids with the knowledge that no harm will come to the autoclave.

Since it is constructed of glassed carbon steel, the new autoclave gives you the corrosion resistance of glass and the structural strength necessary to withstand high pressures. Capacities are 1, 2, and 3 gallons.

You get a wide selection of agitation from the variable-speed drive—the two-blade impeller agitator is glassed steel, too. Provision has been made for a thermometer well and



the nonmetallic rotary seal is equipped with pneumatic lubrication.

To find out more about these new autoclaves, write to us and ask for Bulletin 939.

For more data on advertised products, use Readers' Service Cards, last page.

Corrosioneering News

Quick facts about services and equipment available to help you reduce corrosion and processing costs.

FILM-TYPE EVAPORATOR

You can uncover areas of greater profit with this simple-to-operate still

Pfaudler has added an important new member to its growing family of products – a wiped-film evaporator for vacuum distillation.

It is a new improved evaporator which offers low-cost development opportunities to many industries e.g. chemical process, food, pharmaceutical, plastics, petroleum.

A *floating carbon blade* acted upon by centrifugal force cleanly wipes the peripheral evaporating surface to promote a very thin film and turbulence–creating higher heat transfer rates and faster evaporation.

Here are the benefits you get from using the Pfaudler evaporator:

1. IMPROVED HEAT TRANSFER–Very high heat transfer rates even for highly viscous products due to turbulence promoting carbon blades.

2. SHORT CONTACT TIME–No deterioration for heat sensitive materials.

3. CONSTANT UNIFORM FILM – The walls are wiped by actual contact of the carbon blades. This is the only positive means of inducing controlled turbulence and uniform film thickness. Fouling and solids-build-up are eliminated.

4. LOW-COST PROCESS–Because of the short contact time, high heat transfer rate and low power consumption of this evaporator, your operation can be more efficient and less costly.

5. SPACE SAVING – An internal condenser is built into the still eliminating an external condenser and interconnecting piping.

6. LOW MAINTENANCE RATE – Slow speed wiping minimizes wear. Closely machined tolerances between wall and wiper blades are not necessary because contact between the wiper and the wall is due to centrifugal force. Thermal expansion does not affect the operating efficiency of the wiper blades. No foot bearing is required.

7. LOW PRESSURE DROP – Pressure drops between evaporator and condenser as low as 1/10 mm Hg at one mm Hg operating pressure.

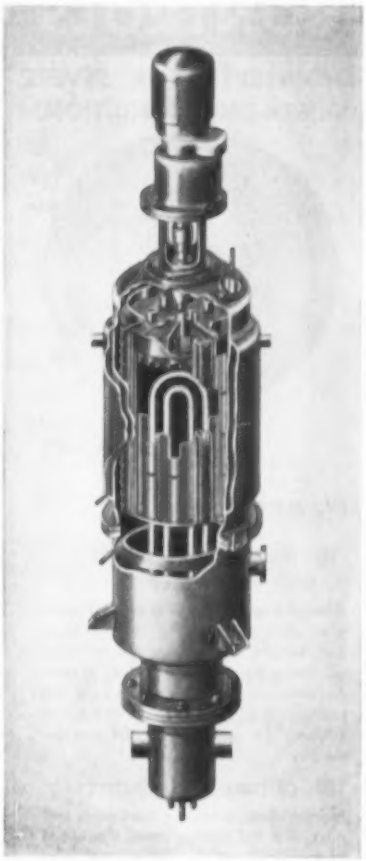
Two models available

Two Inch Laboratory Evaporator, complete with rotor motor, heating mantle, two 500-m.l. receiver flasks, batch-type feed flask, degasser, Teflon wipers, 24/40 standard taper joints.
For 115 volt, 1 phase,
50-60 cycle power $391.00
For 250 volt, 1 phase,
50 cycle power $397.00

Twelve Inch Pilot Plant Evaporator, stainless steel, complete with ¼ HP variable-speed rotor motor, 4 sq. ft. heat transfer surface in jacket, 6 sq. ft. heat transfer surface in internal condenser, vacuums to 0.1 mm or lower, temperatures up to 700 F., very high capacities. For 220 volt, 1 phase, 60 cycle power. (Prices on request.)

Units may be coupled for fractionation. The distributor acts to accelerate the distillate through the evaporator–residence time is less than one second.

In many installations of both the laboratory model and the Twelve Inch Pilot Plant unit, the versatility and high evaporation rate of this new evaporator have been proved. And it has been found that the quality of results from these small units can be dependably duplicated in production size units.



It's easy to test your distilland yourself with the laboratory model. Data you gather will enable you to uncover those areas of greater profit in your own operation. For your needs at that time, Pfaudler offers standard jacketed units in 24-, 36-, 48-, and 60-inch production size models.
Order the Pfaudler Two Inch Laboratory Evaporator now.

Corrosioneers make impartial selection of column material

Equipment users and fabricators alike often ask themselves: What kind of a column is best here?

Users are in a position to be objective when deciding on one column or another. Pfaudler, too, calls on the same objectivity when planning the *fabrication* of one column or another. Owing to their unique experience with both glassed steel and alloy, Pfaudler engineers can make impartial selections of materials.

Careful evaluation is given to each column application. Here are the criteria Pfaudler uses:

1. Low cost and satisfactory corrosion resistance.
2. Easy handling, installation, and cleaning.
3. High vapor and liquid capacity.
4. Low vapor-pressure drop.
5. Top efficiency under high and low loads and under mildly unsteady loads.

Proper *balance* of these conditions is your best guide to a good column purchase. That balance might come from a tray or packed column, a glassed steel or alloy column – Pfaudler's engineers are as impartial in deciding as you are yourself!

No matter what kind of a column application you're planning, you can be sure that Pfaudler will help you to select the *right* column.

For information on Pfaudler columns, ask for Bulletin 940 *and* Data Sheet No. 25.

For more data on advertised products, use Readers' Service Cards, last page.

MERCOID®

PRESSURE & TEMPERATURE

CONTROLS

ENGINEERED FOR SEVERE OPERATING CONDITIONS

Series "D"

Only Mercoid Offers

● ***HERMETICALLY SEALED CONTACT***

Always dependable—whether it operates once per year or several times per minute. It remains operative at all times because dust, dirt, grease or moisture cannot contaminate the contacting elements. There can be no sticking or welding of the contact points.

● ***OUTSIDE ADJUSTMENTS***

Independent outside adjustments are provided for setting both the cut-in and cut-out points. Differential may be widened as desired. No tools are required.

● ***VISIBLE CALIBRATED DIAL***

No guesswork or calculations are required—the pointers indicate on an accurately calibrated dial, the exact operating pressures or temperature.

● ***VISIBLE OPERATION***

You can tell at a glance whether switch circuit is on or off.

● ***BOURDON TUBE OPERATED***

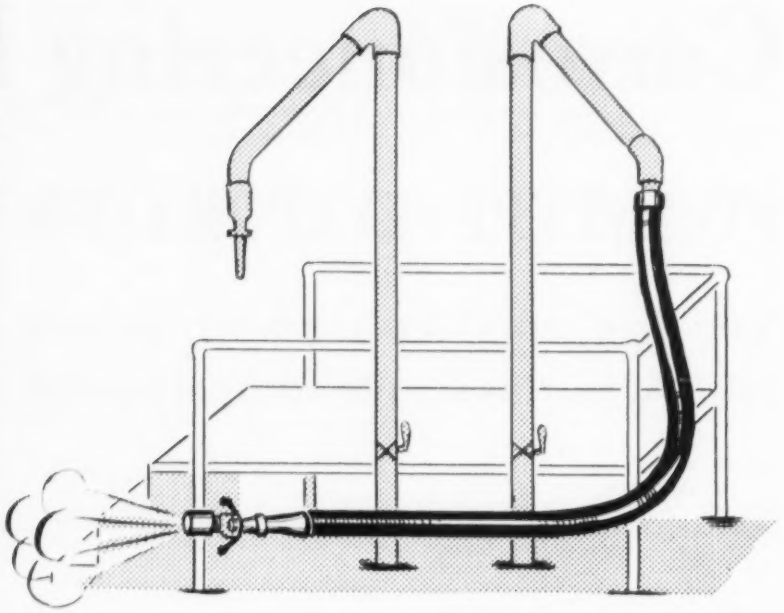
UNDERWRITERS' APPROVED

All operating ranges for Series DA-21, DA-35 and DA-55.

Available for general use, outdoor use or hazardous locations.

WRITE FOR BULLETIN 4B

THE MERCOID CORPORATION
4211 Belmont Ave., Chicago 41, Ill.



chor can be made by screwing a hose coupler into a collar welded to the platform. This allows quick, easy unfastening of the hose for use, and securely locks it when idle.

Hemostats Make Pliers

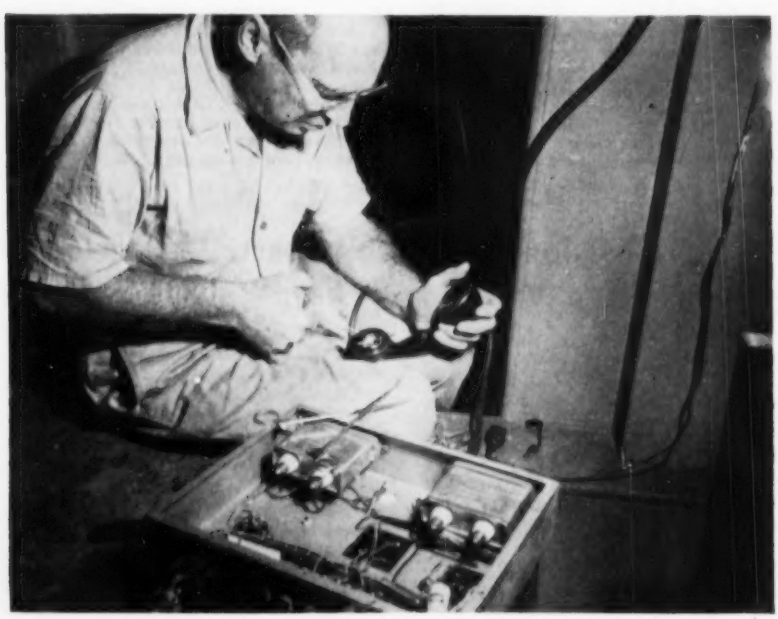
Where the refinery maintenance man must keep up electrical equipment, soldered connections can be made quickly by using surgeon's hemostats which have outlived their usefulness for a doctor.

These clamps can be used as pliers, and when the connections are in place for soldering it is easy to lock the base and solder the connection.

Many surgeons and physicians have these tools which have either become obsolete or are too worn out for their purposes. But they still make a handy aid for the electrician.

Portable Sample Cooler

Corrosion studies sometimes require the determination of pH and CO_2. Since samples taken for this purpose are frequently hot, they must be cooled to prevent flashing of the CO_2. At times, it is desirable to condense



GIRDLER OFFERS YOU...

proven experience in process plants

Girdler ammonia plants are now under construction in Ontario, Maine and Georgia.

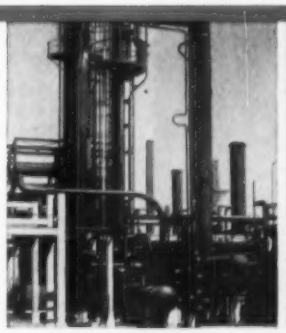
DESIGN: Girdler's research and development department is well equipped to assist with all types of process problems. A technical staff is available for consultation, and Girdler's research group can be employed on special problems at reasonable cost.

ENGINEERING: Experienced executives direct a group of engineering specialists, trained for every job requirement. In addition to basic process and equipment design, Girdler engineers have broad experience in designing buildings, foundations, electrical systems, boiler plants, instrumentation, etc.

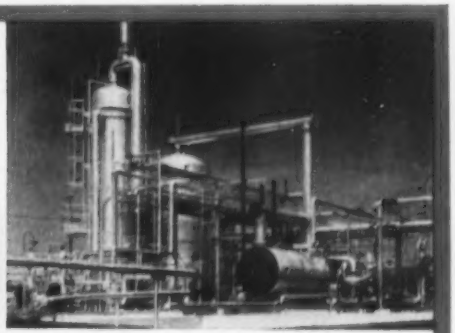
CONSTRUCTION: Girdler engineers supervise and direct all phases of construction for safe, on-time results. When the job is completed, experienced operating engineers will start up the plant, train operating personnel, run acceptance tests and supply complete operating data.

Hydrogen Plants	Nitric Acid Plants
Chemical Processing Plants	Acetylene Plants
Hydrogen Sulfide Plants	Sulphur Plants
Synthesis Gas Plants	Ammonia Plants
Carbon Dioxide Plants	Formaldehyde Plants
Gas Purification Plants	Ammonium Nitrate Plants
Plastics Materials Plants	Fertilizer Plants
Carbon Monoxide Plants	Phosgene Plants

Catalysts & Activated Carbon



This Girdler GIRBOTOL plant purifies both liquid and gaseous hydrocarbons.



This Girdler plant recovers elemental sulphur from hydrogen sulphide.

• Take advantage of Girdler's proven experience when you start to plan your processing facilities.

the **GIRDLER** Company

A DIVISION OF NATIONAL CYLINDER GAS COMPANY

LOUISVILLE 1, KENTUCKY

GAS PROCESSES DIVISION... Design, Engineering, Construction of Hydrocarbon Processing Plants, Gas Plants, Chemical Plants. Offices: New York, San Francisco

For more data on advertised products, use Readers' Service Cards, last page.

NOW...

a Transistorized

ELECTRONIC PROCESS CONTROL SYSTEM

'American-Microsen' presents a new all-electronic process control system with...

Transistorized instruments.

All measurement and control functions contained in just three basic units.

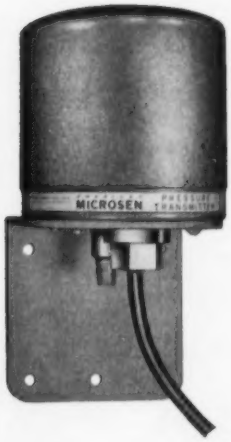
Each unit contained in a single, compact housing.

The *transistorized* electronic Controller has all control room components within one, panel-mounted case. *Transistorized* for highest reliability and compactness, this new instrument saves both panel space and wiring... means better process control for a smaller investment.

For transmission, control and valve operation based on the proved 'American-Microsen' System, be sure to visit:

The I.S.A. Conference and Exhibit
Manning, Maxwell & Moore, Inc.
Booths 404-409
New York Coliseum
September 17-21, 1956

THE TRANSMITTER



The new Series 185 Pressure Transmitter is a miniaturized version of the well-known 'American-Microsen' Pressure Transmitter. It incorporates the latest mechanical and electrical features to achieve maximum operating benefits and usefulness.

The time-tested "Microsen" balance creates a stable dc signal for long distance transmission. Bearing pivots and linkages are entirely eliminated. Consequently, sensitivity is practically infinite, and repeatability of measurement is within 0.001% of range span.

Printed circuitry and miniaturized components reduce the size of the transmitter to only 4⅞" in diameter and 5¼" high. In dust and weatherproof case designed for universal mounting, the Series 185 can be firmly supported on meter piping, pipe pedestal or vertical surface.

'American-Microsen' Transmitters of similar design are available for differential pressure, flow, temperature and other variables.

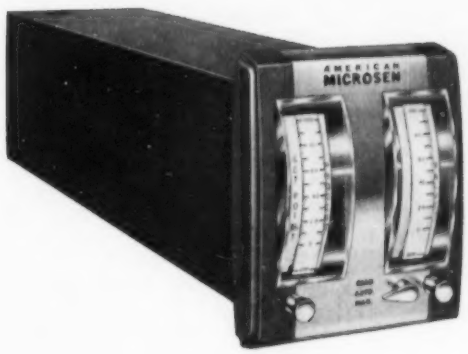
MANNING,

MAKERS OF 'AMERICAN-MICROSEN'

M7-56

For more data on advertised products, use Readers' Service Cards, last page.

THE CONTROLLER



The Series 164 Controller provides a complete controlling system in a single panel-mounted housing. Now one compact transistorized unit handles *all* control functions: indicating or recording the process variable, controlling, and manual-automatic operation. Transistorized design greatly improves reliability and service life. Savings in panel cost are tremendous because of miniaturization and consolidation of control functions – because no longer is it necessary to wire several units externally.

The Series 164 is available as a Recording Controller, compact Indicating Controller and as a long-scale Indicating Controller. Each functional unit is contained on a separate plug-in chassis within the housing. Each unit can be removed and replaced within moments without disturbing the operation of the other units.

THE OPERATOR

In 1955 we introduced the 'American-Microsen' Electro-Hydraulic Control Valve Operator – a power unit with position feedback to operate control valves, dampers, etc. It completely eliminated the need for compressed air.

More than a year of efficient performance in field service was paralleled by further engineering developments that culminated in the new Series 181 Electro-Hydraulic Control Valve Operator. This improved unit offers simplified design characteristics that mean even lower cost and greater reliability than its predecessor.

The Series 181 Electro-Hydraulic Control Valve Operator is mountable on standard yokes supplied with conventional slip-stem control valves with bodies of single or double-seated construction, with V-port, parabolic, needle and equal-percentage plugs. It can be furnished for all valve sizes, including those of 4" stroke, and with force available up to 3,250 lbs.

MAXWELL & MOORE, INC.

INDUSTRIAL CONTROLS DIVISION

Stratford, Connecticut

ELECTRONIC INSTRUMENTS FOR MEASUREMENT, TRANSMISSION AND CONTROL

MAXWELL MANNING & MOORE INC. TRADE MARK

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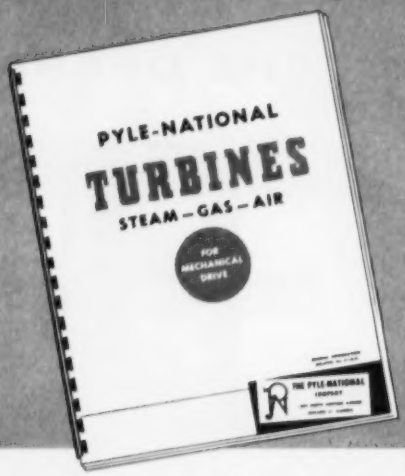
Do you have a mechanical drive problem?



TURBINE SELECTION AND ENGINEERING DATA BOOK

The most complete reference available to answer your questions on turbines . . . at-a-glance information on speeds, B.H.P., pounds-steam/B.H.P.-hour at various steam pressures.

Request your copy today on your company letterhead.

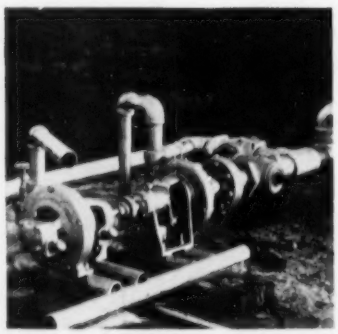
59 years' experience in turbine development

PYLE-NATIONAL TURBINES

¼ to 120 HP for mechanical drive

—the turbines that ask no favors in the refinery or in the field

- Weatherproof!
- Rugged!
- Trustworthy!
- Easiest of all turbines to service and maintain!



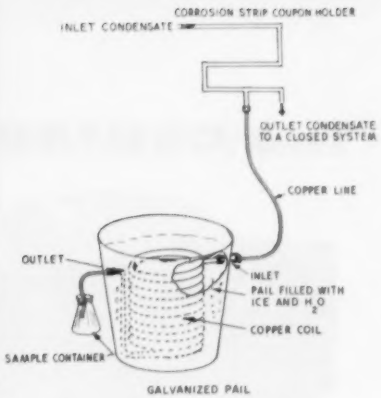
Also available: Turbo-Generators (½ to 15 KW)
Turbo-Alternators (60 cycle ½ to 20 KW)

SINCE 1897

THE PYLE-NATIONAL COMPANY
WHERE QUALITY IS TRADITIONAL
1393 N. Kostner Avenue, Chicago 51, Illinois

Branch Offices and Agents In Principal Cities of the U.S. and Canada • Canadian Agent: The Holden Co., Ltd., Montreal • Railroad Export Department: International Railway Supply Co., 30 Church St., New York 7, N.Y. • Industrial Export Department: Rocke International Corp., 13 E. 40th St., New York 16, N.Y.
CIRCUIT CONTROLS • PLUGS AND RECEPTACLES • LIGHTING FIXTURES • FLOODLIGHTS

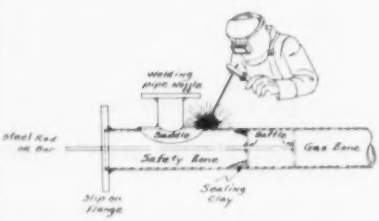
How to Do It . . .



the sample before bottling.

A very convenient portable condenser can be shop-fabricated for this purpose by fitting a copper coil to the inside of an ordinary bucket, as shown. The pail can then be filled with water or water and ice as needed.

Use of this cooler allows more effectice duplication of results and reduces a possible scalding hazard.



Pipe Plug Prevents Explosion

Here is a method of safety cutting into a line with a welding torch without first gas-freeing the entire line:

First, disconnect near the point of welding if a flange is available; otherwise, saw the line in two.

Next, insert a pipe plugging device made from two baffle plates attached to a single rod. The double plate arrangement provides stability and makes the plug self-supporting.

Then, seal the gap between the pipe and the plug with some type of sealing compound—even mud if necessary.

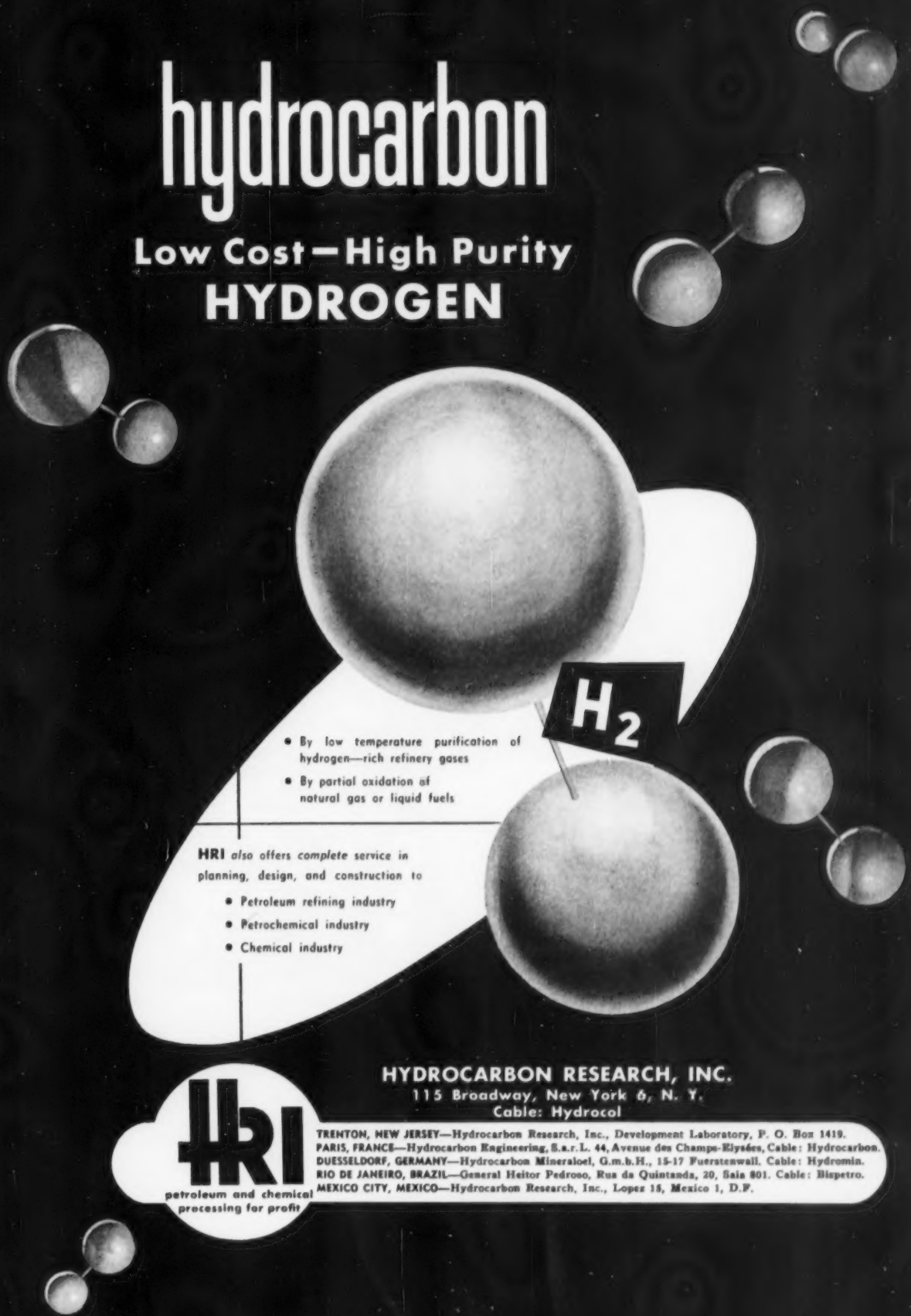
When the plug has been sealed, blow fresh air into the short, open section of pipe until the explosimeter reading is zero.

Now, proceed with repairs or new connection, then pull out the plug and flange up the job.

For more data on advertised products, use Readers' Service Cards, last page.

hydrocarbon

Low Cost—High Purity HYDROGEN



- By low temperature purification of hydrogen—rich refinery gases
- By partial oxidation of natural gas or liquid fuels

HRI *also offers complete service in* planning, design, and construction to

- Petroleum refining industry
- Petrochemical industry
- Chemical industry

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Cable: Hydrocol

HRI
petroleum and chemical processing for profit

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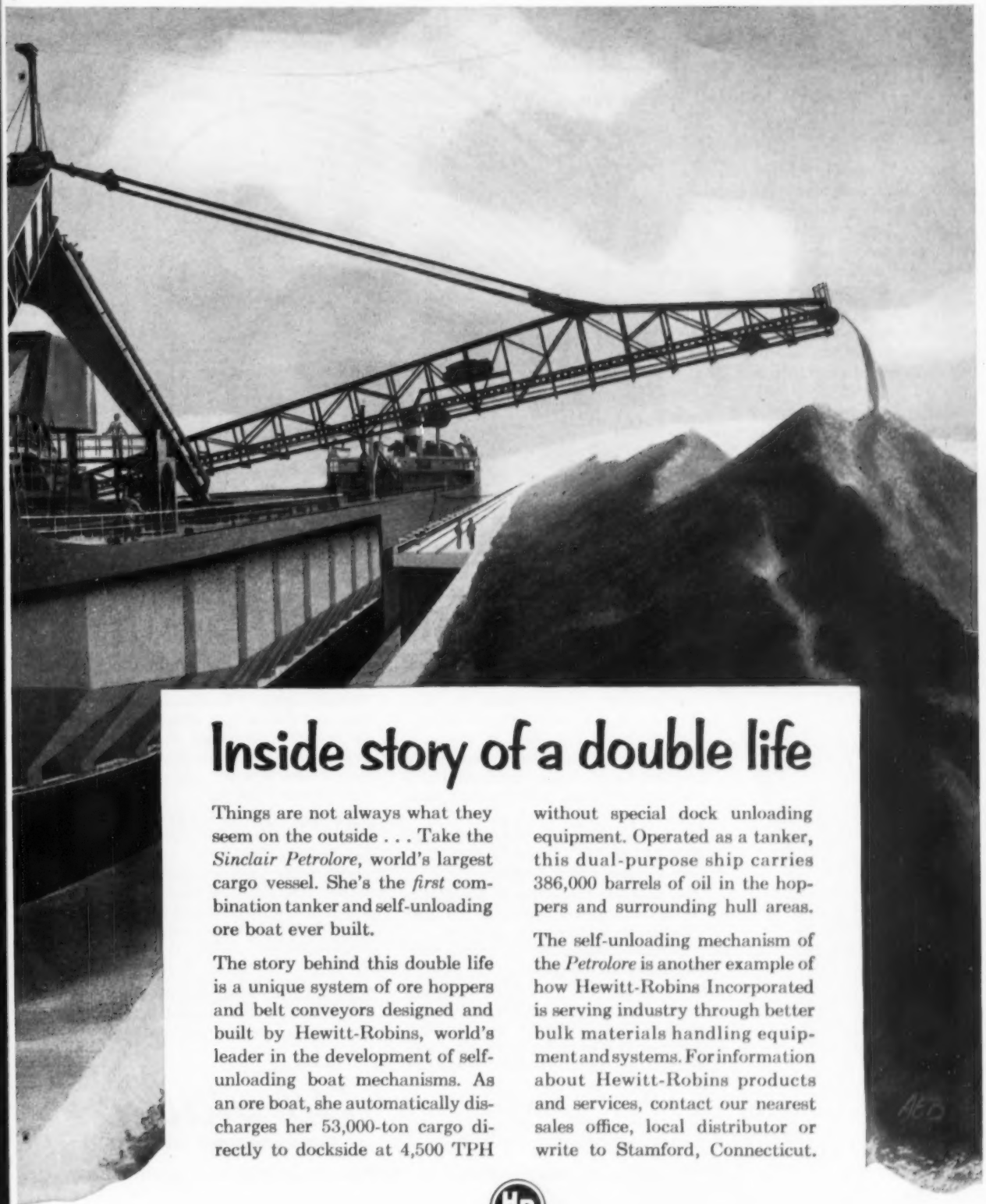

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The story behind this double life is a unique system of ore hoppers and belt conveyors designed and built by Hewitt-Robins, world's leader in the development of self-unloading boat mechanisms. As an ore boat, she automatically discharges her 53,000-ton cargo directly to dockside at 4,500 TPH without special dock unloading equipment. Operated as a tanker, this dual-purpose ship carries 386,000 barrels of oil in the hoppers and surrounding hull areas.

The self-unloading mechanism of the *Petrolore* is another example of how Hewitt-Robins Incorporated is serving industry through better bulk materials handling equipment and systems. For information about Hewitt-Robins products and services, contact our nearest sales office, local distributor or write to Stamford, Connecticut.

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The amazing flexibility of Flexitallic Gaskets compensates for the variable stresses encountered in service . . . prevents contamination where corrosive conditions exist.

Since 1912, engineers have been designing for safety with Flexitallic, the original Spiral-Wound Gasket. It's why we at Flexitallic work conscientiously to maintain this respected standard of quality.

Each Flexitallic Gasket is designed and engineered to meet specific conditions of thermal and physical shock, corrosion, vibration, weaving and unpredictable joint stresses. Spirally-wound V-crimped plies of required metal with alternating plies of proper filler result in a resilient gasket having controlled compression characteristics like those of a precalibrated spring.

Flexitallic Gaskets are at highest efficiency when bolted up cold at a predetermined load. For all pressure-temperature ranges from vacuum to 10,000 lbs., from extreme sub-zero to 2000°F. For all standard joint assemblies. In four thicknesses for special requirements: .125", .175", .250", .285".

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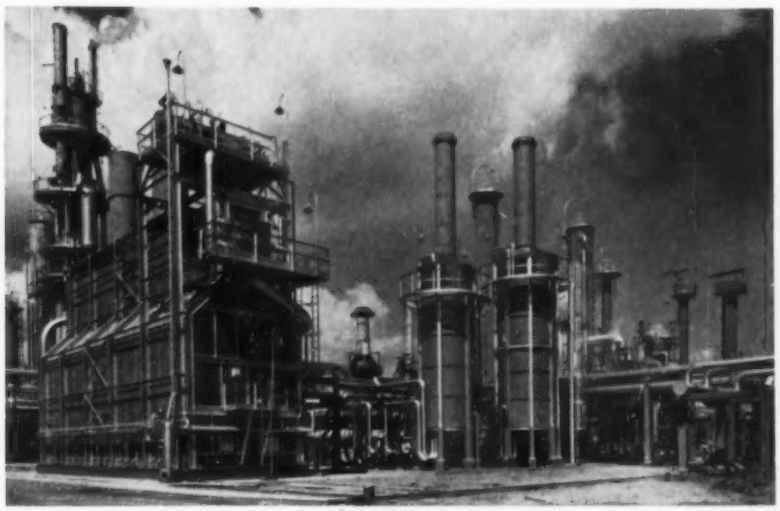
*Flexitallic is a registered trade name. No one else can make a Flexitallic Gasket. Look for *Flexitallic Blue*—it's our exclusive blue-dyed Canadian asbestos filler.

Who's Building . . .

Next Construction Boxscore will appear in the October issue.



Pontiac Unit On Stream—

Pontiac Refining Corporation recently put into operation a new Platformer at its Corpus Christi refinery. This is Pontiac's second unit and raises its catalytic-reforming capacity to more than 13,000 barrels a day. The new unit was designed to produce 100-plus octane number gasolines out of heavy low-grade naphthas. The new reformer was designed by Universal Oil Products Company and engineered and constructed by The Fluor Corporation, Ltd., in six months.

Shown, left to right: charge heater, stabilizer reboiler heater, stabilizer (in background), rerun tower reboiler and rerun tower.

Japanese Refiners Continue Postwar Construction Boom

. . . Contracts for three more projects help sustain the continuing activity found in Japan's refining and petrochemical industries.

JAPAN is increasing the activity of its petroleum-refining and petrochemical industries.

Idemitsu Kosan Company, Ltd., is building a new refinery on the site of a Japanese naval depot and refinery that was bombed out in World War II. Daikyo Oil Company, Ltd., is increasing its refining facilities with the installation of a new catalytic-reforming unit.

And in petrochemicals, Mitsui Petrochemicals Industries, Ltd., has started construction on a phenol plant.

Idemitsu Kosan Company, Ltd., has broken ground for a new 30,000-barrel-a-day refinery on the site of the former naval depot at Tokuyama. The refinery, which is expected to cost approximately $25 million, will go into operation next year.

Universal Oil Products Company licensed four processes which will be operated at the refinery—fluid catalytic cracking, Platforming, Unifining and Unisol. An atmospheric and vacuum crude-distillation unit and an asphalt plant also are being built.

Other equipment for the refinery will include a carbon monoxide-fired boiler. The CO, normally a waste material, will be produced in the cracker.

The Japan Gasoline Company, Universal's licensing agent in Japan, will build the new refinery.

Daikyo Oil Company, Ltd., will build a 3000-barrels-per-day Houdriforming unit for high-octane gasoline production at its Yokkaichi refinery.

The refinery's 4200-barrel Houdriflow catalytic cracker, first in the Far East, has been on stream more than a year. Daikyo's new Houdriformer, also first in the Orient, is scheduled for completion next summer.

The new catalytic-reforming unit will consist of three catalytic reactors plus Houdry Process Corporation's integrated pre-treat catalytic guard-case reactor for feed stock purification. Apparatus for possible in-place regeneration of the platinum catalyst will be built as an integral part of the unit.

The reformer will produce high-octane gasoline from the high-paraffin, high-sulfur naphthas derived from the Middle East crudes processed at the Yokkaichi refinery.

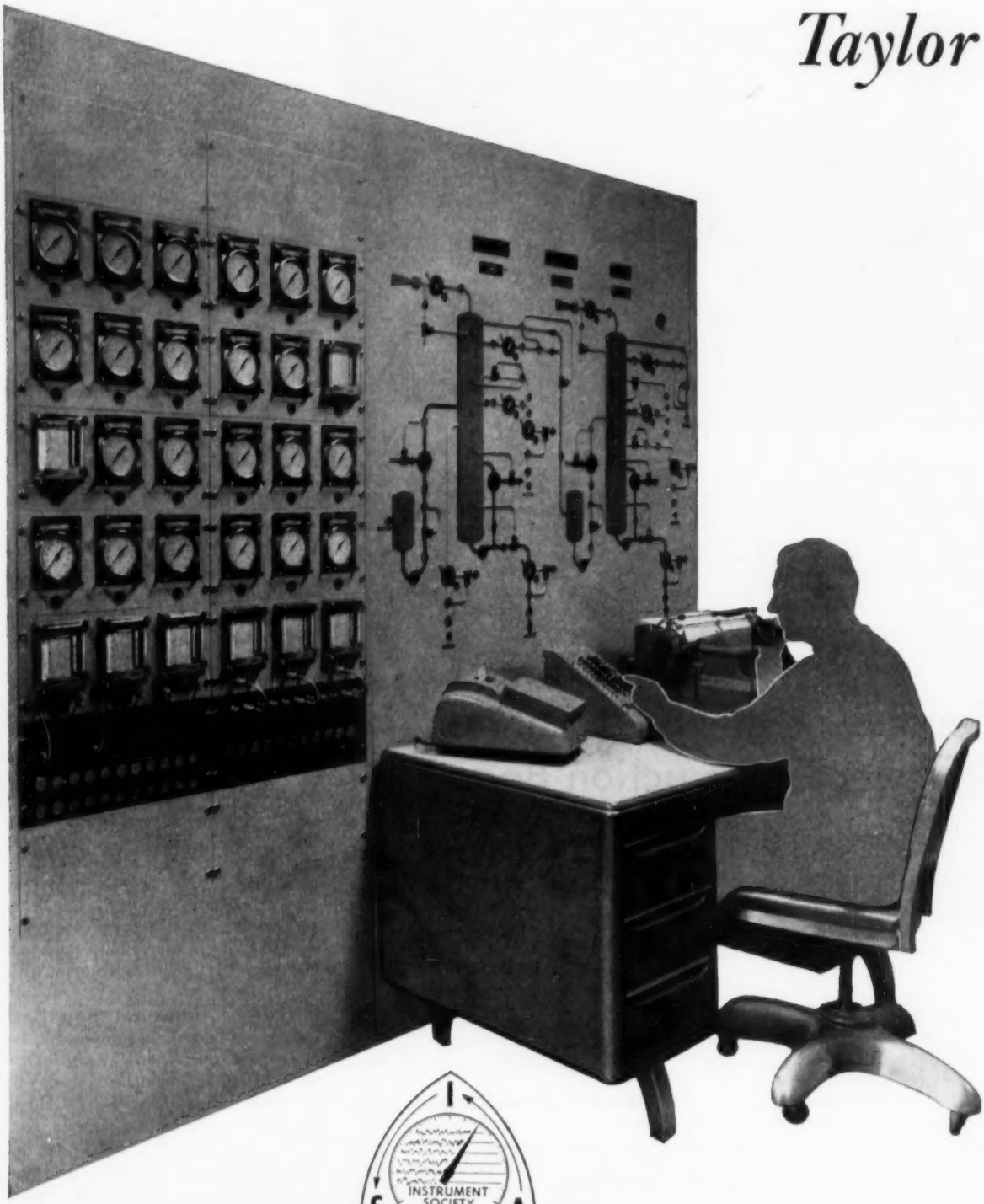
Houdry Process Corporation furnished the process design for the new unit, and will do part of the engineering, on which The Refinery Engineering Company also has been engaged. Daikyo will handle construction.

Mitsui Petrochemical Industries, Ltd., has awarded the contract for the design and supervision of construction for a new phenol plant. The work will be handled by Stone & Webster Engineering Corporation.

The new installation will be the first of its kind in the Orient and one of several major units being erected for Mitsui at Iwakuni City. Stone & Webster also is designing another unit

BIGGEST NEWS

Taylor



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Trans-Scan-Log Control System!

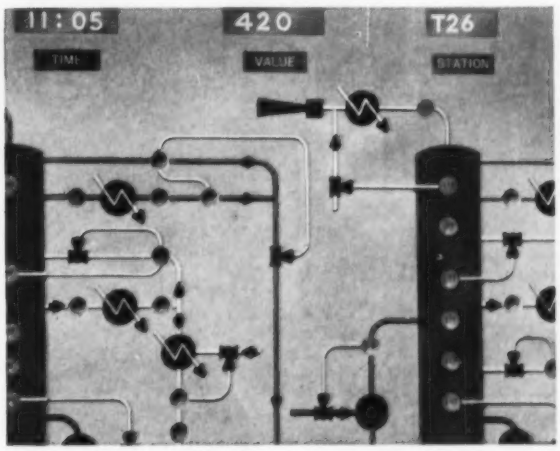
MAKE the Taylor booths your headquarters for scanning and logging at this year's ISA Show. You will see an actual working model of the TSL System . . . the soundest and the most logical integration of process control with process scanning and logging yet devised . . . *a boon to advanced systems engineering.*

The Taylor system goes far beyond today's practices. It is, in essence, a very compact intelligence center which coordinates all related process data, enabling the operator to instantly visualize, evaluate and act upon every processing irregularity as it occurs—without leaving his desk in front of the panel. In addition, it employs the most modern techniques in scanning and logging. Thus the project engineer can observe the entire plant operation more efficiently than ever before.

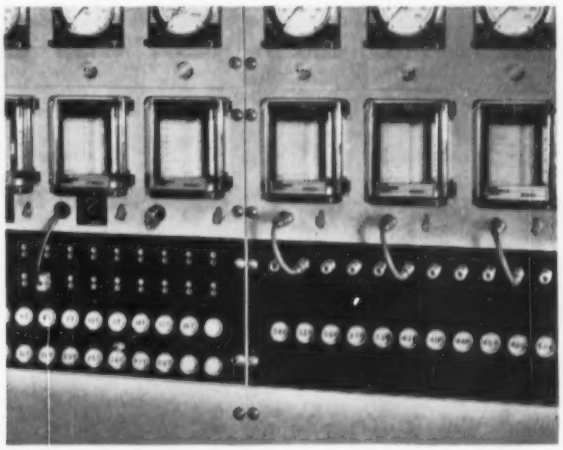
As well as furthering automation in plant operation, the TSL System is a research tool in collecting data on existing units. It can provide accounting or marketing departments with production data as it is accumulated, either on punch cards or tape.

The complete system takes approximately 60% of the space normally required by a standard graphic panel *without* scanning and logging. Because of this compactness one operator can identify and correct any off-normal condition, as well as having a continuous trend record. It is highly dependable, because the Taylor system makes it possible to use simpler, less expensive units.

Nearly two hundred process engineers from all over the country have already visited Rochester to see this advanced equipment demonstrated. If you are unable to visit the ISA Show your Taylor Field Engineer will be glad to make the necessary arrangements for you to see the TLS system in operation. Meanwhile, write for **Bulletin 98268.** Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.



Graphic Panel—A normal 20-foot graphic panel can easily be compressed into a 5-foot section because space is not required for receivers. Flow lines and symbols can be modified quite simply for process changes. Station identifications are illuminated, also digital readout of time, value and station for on-demand or off-normal. (Off-normal alarm also audible). Point scanning is continuous at the rate of one per second. Scheduled point logging can be set as required.



Process Control Panel—Note plug-in TRANSET* pneumatic control stations, complete with automatic to manual switching. Recorders and indicators are easily interchangeable. All internal connections are completed, ready for field hook-up. Station identification lights give visual tie-in with graphic panel. Convenient electrical and pneumatic plug jacks are provided to record trends of any non-controlled variables.

*Reg. U. S. Pat. Off.

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Who's Building. . .

for the production of propylene and ethylene.

Besides these plants, Stone & Webster has been awarded contracts for an ethylene plant for Sumitomo Chemical Company and isopropyl-alcohol units for Nippon Petrochemicals, Ltd.

Continental Carbon Company has opened a new carbon-black plant near Eunice, N. M. The company is an affiliate of Witco Chemical Company. The new furnace-type plant is the first of its type in New Mexico. It will produce carbon black through the controlled combustion of natural gas.

The British Petroleum Company, Ltd., is adding two major units to the Antwerp refinery it owns with Compagnie Financiere Belge des Petroles, S. A. New facilities for the Belgian refinery will be an 8000-barrel-a-day Hydrofiner and a 7000-barrel-a-day catalytic-reforming unit.

Industries Siciliane Lavorazione Olii Minerali is due to start construction on a 12,000-barrel-a-day refinery at Palermo. The refinery will be completed in 1957 and later expanded to a 20,000-barrel-a-day capacity.

Southwestern Agrochemical Corporation is planning to build Arizona's first fertilizer and ammonia plant. At Chandler, the new plant will cost about $5 million.

Imperial Chemical Industries, Ltd., will install its third and largest catalytic cracker at Wilton in Yorkshire. The new plant will be used to make ethylene for the manufacture of polyethylene. When the new unit goes on stream in 1959, the company will boost its alkathene output to more than 90,000 tons a year. The first cracker at Wilton began operation in 1951, and the second will be started up late this year.

Maruzen Oil Company, Ltd., is expected to ask the Japanese government to approve construction of a 5000-barrel-a-day refinery at Bangkok, under Japan's reparations program for Thailand.

Sunray Mid-Continent Oil Company has placed in operation a new cycling plant near Church Point, La. The plant processes some 230 Mmcf. of gas a day and produces almost 2200 barrels a day of stabilized distillate, butane and propane.

Compagne Francaise de Raffinage has acquired a 2-million-volt Van de Graaff particle accelerator for its laboratory in Paris. The machine will be used in fundamental research into the effect of radiation on petroleum products. It was purchased in the U. S. from High Voltage Engineering Corporation.

Union Oil & Gas Corporation, in partnership with Texas Gas Exploration Corporation, has awarded the contract for engineering and construction of a 30-Mmcf.-a-day gasoline-extraction plant at Eunice, La. The project will be handled by The Fluor Corporation, Ltd. It is scheduled for completion in June 1957.

Montana Sulphur & Chemical Company has placed on stream a new sulfur plant near Billings, Mont. Using hydrogen-sulfide gases from the nearby refineries of The Carter Oil Company and Continental Oil Company, the new plant will have the capacity to produce 40 long tons of sulfur a day. Badger Manufacturing Company handled design and engineering for the plant, and Proctor Engineering Company was prime contractor.

Standard Oil Company (New Jersey) has asked the Norwegian government for approval of its plans to build a 40,000-barrel-a-day refinery in southern Norway. The company wants to build the refinery at Skjerbgkilen on the Oslo Fjord.

Wyandotte Chemicals Corporation will build a plant near Baton Rouge for the production of ethylene-oxide glycol by a new process. The plant, which is expected to cost $8 million, will produce about 60,000 pounds of ethylene oxide a year. Construction will be started early in 1957, and the plant is scheduled to go into operation that fall.

Union Oil & Gas Corporation, with Texas Gas Exploration Corporation, will build a 300-Mmcf.-a-day natural-gasoline plant near Eunice, La.

Premier Oil Refining Company is planning a $1.25-million modernization of its 4500-barrel-a-day refinery at Longview, Texas. Most of this will be used to install a new Platformer and Unifining unit. Some of the money will go to augment existing facilities, including a thermal-cracking unit. Construction will be completed early in 1957.

Spencer Chemical Company has become the second licensee of the Standard Oil Company (Indiana) low-pressure process for making polyethylene. The license issued to the Kansas City, Mo., concern covers more than 20 issued patents as well as a number of pending applications. Polypropylene and copolymers of ethylene and propylene also are included. Eastman Kodak Company was the first company to receive a license to use the process.

Shell Chemical Corporation has awarded the contract for design, engineering and construction of utilities and offsite facilities for its methyl-ethyl-ketone plant at Norco, La. The work will be handled by The Fluor Corporation.

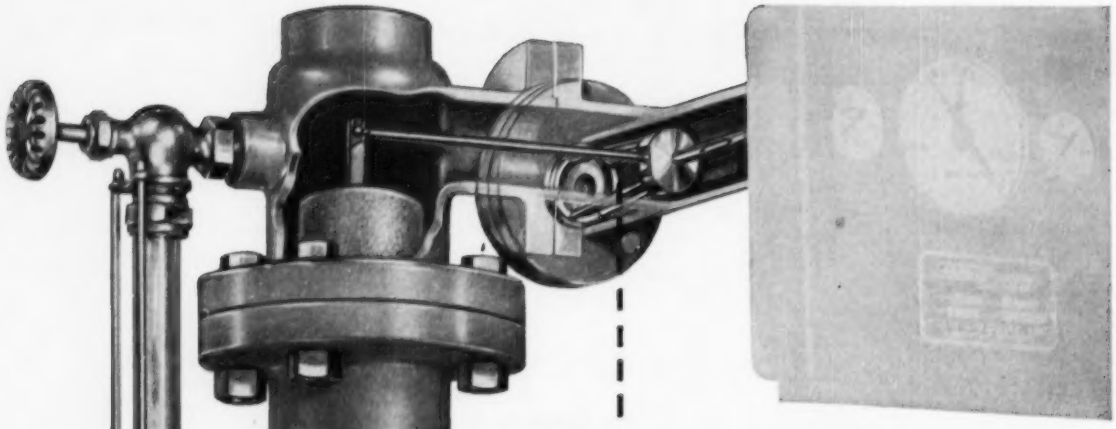
Allied Chemical & Dye Corporation has plans for building a New Jersey plant to manufacture sulfuric acid from raw materials supplied by the Bayway re-

Texas Plant Half Complete

This is a general view of the compressor-absorption area of the butadiene plant Texas Butadiene & Chemical Corporation is building at **Houston.** It is more than half completed.

Engineered and constructed by The Fluor Corporation, Ltd., the $30-million plant will use the fixed-bed catalytic dehydrogenation process developed by Houdry Process Corporation and a furfural extraction unit licensed by Phillips Petroleum Company's Perco division. The plant, which will be the first of its type, will produce 65,000 tons a year of blended aviation gasoline and 83,000 barrels of motor alkylate. The plant is scheduled to be in operation early in 1957.

At the center are the foundations of the compressors. At the left is the fired reboiler for the splitter tower. The tower at the left is the butylene splitter and other towers are miscellaneous fractionating columns.



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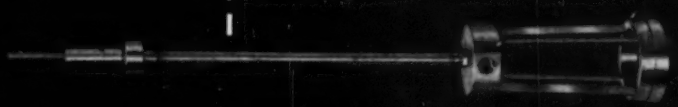

actuated by a torque rod that does not twist. Both torque tube and torsion table legs are Inconel-X . . . a special material resisting corrosion and fatigue alike. Five million cycles has shown no detrimental effect.

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finery of Esso Standard Oil Company. The new plant, to be erected at Elizabeth, will be operated by the company's General Chemical division.

Standard Oil Company of California will have a plant in operation for the production of benzoic-toluic acid at Richmond by late 1956. The new unit will turn out benzoic-toluic in a ratio of 87:13, as a byproduct of the company's isophthalic plant.

General Tire & Rubber Company has started a major expansion of its plant at Ashtabula, Ohio, increasing its vinyl-resin capacity by 50 percent. The plant has been turning out resins at the rate of 25 million pounds a year. United Engineers & Constructors, Inc., is in charge of the project.

Sioux Oil Company is due to complete a light-ends recovery unit at its Newcastle, Wyo., refinery. The new unit was to have cost $85,000.

Westland Oil Company is planning an expansion for the Williston, N. D., refinery it acquired last year at a bankruptcy sale. The project will increase capacity from 1500 to 2000 barrels a day. A thermal cracker also will be installed, and a catalytic reformer will be added later.

New England Industries, Inc., with plans for a new refinery at Bellingham, Wash., has been granted a fast tax write-off on $14.3 million of the $18 million required to put the plant into operation. The new refinery will be built for a daily capacity of 1500 barrels, most of which will be used to produce alkylate. The Office of Defense Mobilization allowed the company 100 percent on the cost of the $9,900,000 alkylation unit and 40 percent on $4,255,000 of refining equipment. Accelerated amortization will not be permitted on the plant's butadiene facilities. These, with the price of land, will cost $3,695,000. Construction will be started early in 1957.

Ceylon Government has killed plans for a $35-million refinery which would have been jointly owned by The California Texas Company, The British Petroleum Company, Standard-Vacuum Oil Company and the Royal Dutch/Shell Group. Government spokesmen called the plan "too monopolistic." The government, however, is willing to receive new proposals.

Delhi-Taylor Oil Corporation will install a 14,000-barrel-a-day Unifining-Platforming unit and a 4500-barrel-a-day Udex unit at its Corpus Christi refinery. The Refinery Engineering Company was awarded the contract to design and construct the units, under license from Universal Oil Products Company. In addition to turning out gasoline above 100 octane, the new units will produce benzene, xylene and toluene.

Standard Oil Company of California has selected The Fluor Corporation, Ltd., to handle engineering and design of new crude-handling facilities at its El Segundo, Calif., refinery. The project will cost about $3 million. Engineering work will start immediately, with construction scheduled to begin in November.

Who's Building...

Houilleres du Bassin de Lorraine has engaged Koppers International, S. A., to furnish engineering design and operating "know-how" for a polyethylene plant to be built in France. The plant, to be in Moselle, probably will be near the styrene-monomer plant Houillere du Bassin de Lorraine is building at Carling, under license from Koppers Company, Inc.

Canadian Oil Companies, Ltd., has awarded the contract for a $3-million petrochemical plant at its Sarnia refinery. The contract, which went to The Fluor Corporation of Canada, Ltd., calls for the engineering and erection of a Udex plant with a daily capacity of 3650 barrels and a 4400-barrel-a-day Platforming unit. Construction will be started this fall, with the plant scheduled for completion next summer. The Udex plant will be the first of its kind in Canada for the extraction of benzene, toluene and xylene. The new Platformer will be the second at the Sarnia refinery. It will be used to produce charging stock to the Udex unit.

Frontier Refining Company is expected to start construction this fall on a new refinery at Fort Pierce, Fla. Previously, the Denver concern had indicated the plant would be built under the name of a subsidiary Seminole Oil Company.

American Oil Company will build a second large Ultraforming unit at its Texas City refinery. The new unit, which will have a capacity of 21,000 barrels a

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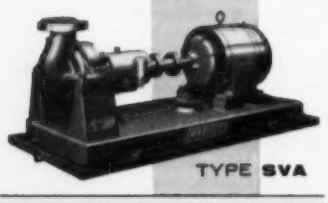

TYPE SVA

RATINGS	TYPE SVA	TYPE SVS	TYPE SVC	TYPE RVC
Capacity — in GPM	15 to 1300	15 to 1000	25 to 3200	50 to 600
Pressure — in PSIG	To 600	To 600	To 600	To 600
Head — in feet	To 600	To 600	To 600	To 900
Temperature — °F	To 300	To 300	To 850	To 850
Number of stages	One	One	One	Two

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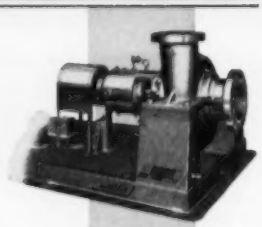
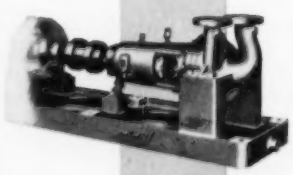


TYPE SVC



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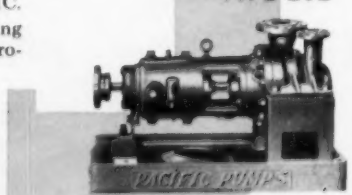

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Who's Building...

day, will be equipped for naphtha-desulfurization facilities. The company expects to award the contract this fall and complete the unit before the end of 1957.

Pan Am Southern Corporation has awarded the contract for construction of a second Ultraforming unit at its El Dorado, Ark., refinery. The unit, to be built by The Lummus Company, will have a daily capacity of 6200 barrels. The refinery's first Ultraformer, completed more than two years ago, has a capacity of 6800 barrels a day. The new unit will go on stream next summer.

Gulf Oil Corporation plans to build a 26,000-barrel-a-day Platforming unit at its Port Arthur, Texas, refinery. The new unit will be the second of its kind at the Port Arthur refinery. The first was put in operation a year ago, with a daily capacity of 29,000 barrels. The new unit, licensed by Universal Oil Products Company, will be installed by Procon, Inc. Construction will be started this year, with the unit scheduled to go into operation early in 1958.

Texas Natural Gasoline Corporation will build a plant near Baker, Mont., designed to process 50,000 gallons a day of natural-gas liquids. Design, engineering and construction of the plant will be done by the staff of the company. The new facility is due to be on stream in November 1956.

The British American Oil Company, Ltd., is continuing construction of the natural-gasoline plant Canadian Gulf Oil Company had started near Nevis, Alba. Initial planning and construction was begun by the Gulf Oil Corporation before it was acquired recently by British American. The plant is designed to handle 20 Mmcf. of natural gas a day, turning out gasoline, propane and butane.

Standard Oil Company (Indiana) has construction underway on its third polybutene plant. The new unit is being built by a subsidiary, Pan-Am Southern Corporation, at Pan-Am's Destrehan, La., refinery.

The Ohio Oil Company has started construction on a new control laboratory at its refinery at Robinson, Ill. The new laboratory, intended to replace the existing facility, will be completed early next year.

Navy Department has awarded Callery Chemical Company the contract to build a $38-million high-energy fuel plant on government-owned land near Muskogee, Okla. Design work was scheduled to start immediately.

Goodrich-Gulf Chemicals, Inc., has awarded the contract for construction of a new boiler house for its recently-acquired synthetic-rubber plant at Institute, W. Va. The new plant, to be installed by The Girdler Company, will cost $1.5 million. It is designed to generate 100,000 pounds of steam an hour in two boilers. Space will be provided for a third 50,000-pound boiler should additional steam be required for later operations of the 122,000-ton plant. The company is owned jointly by the B. F. Goodrich Company and Gulf Oil Corpo-

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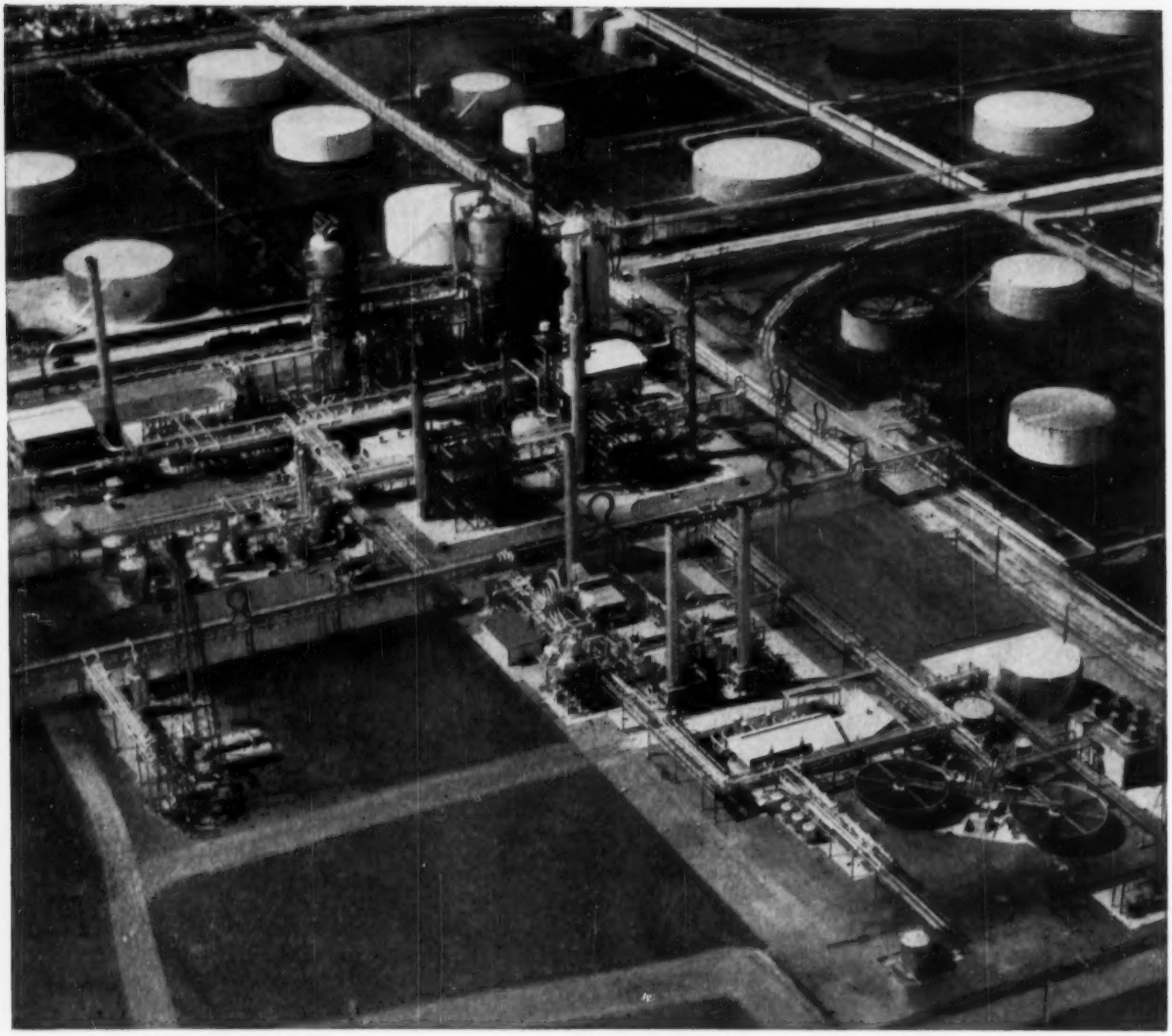

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Who's Building . . .

ration. It purchased the Institute plant from the government earlier this year for $11 million.

Cosden Petroleum Corporation, with a new 4000-barrel-a-day Rexformer in operation at its refinery at Big Spring, Texas, has been able to release its benzene-toluene-xylene plant to full-time production of aromatic chemicals. The result has been a 30 percent increase in the output of nitration-grade benzene, toluene and xylene.

The Southland Company, with plans for a 15,000-barrel-a-day Florida refinery, has purchased land for such a plant at Black Point, near Tampa. There were no immediate plans to start construction.

Southland operates a 5500-barrel-a-day refinery at Sandersville, Miss., and recently acquired the 6000-barrel-a-day Delta Refining Company plant at Memphis.

The company is planning to expand capacity of the Memphis refinery to 10,000 or 11,000 barrels a day. Included in the program will be an expansion of the plant's existing 3100-barrel-a-day catalytic cracker and the addition of an alkylation unit.

Ingram Products Company has completed a major phase of its refinery-expansion program at Meraux, La., with the start up of a 3000-barrel-a-day catalytic-reforming unit. The new unit is a Platformer designed to produce 98- or higher-octane gasoline. It is processing a mixture of natural gasoline and gasoline produced from crude. The charging stock has a boiling range of 200 to 400 F. Work is now underway at the Meraux refinery on revamping the crude unit to increase its capacity to 12,000 barrels a day.

The Texas Company will start construction this fall on an ammonia plant with a 180-ton-a-day capacity at its Lockport, Ill., refinery. The plant will have facilities for converting part of the ammonia to nitrogen solutions. It is due to be in operation late in 1957.

When completed, the Lockport plant will be Texaco's second major petrochemical facility. The first, an additive plant at the company's refinery in Port Arthur, will begin production early next year.

Design, engineering and construction of the new Lockport plant will be done by Foster Wheeler Corporation.

Orogil is a new French company organized to manufacture lube-oil additives in France. The company was organized by Oronite Chemical, a subsidiary of Standard Oil Company of California, and Progil, a French chemical firm.

The new company will build a plant using processes and techniques developed by Orinite. It will turn out certain derivatives of phenol and other basic chemicals. An output of 5000 tons of lube additives a year is planned.

Neches Butane Products Company is scheduling a 50-percent expansion of its butadiene plant at Port Neches, Texas, to bring capacity to 300,000 short tons a year. The plant was purchased from the government by Texas-U. S. Chemical

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Company and Goodrich-Gulf Chemicals, Inc., in May 1955 for about $53 million. It had a rate capacity of 190,000 tons a year and was the largest plant constructed under the wartime synthetic-rubber program. Part of the plant's output will be used in adjacent synthetic rubber plants owned by Texas-U. S. and Goodrich-Gulf. Texas-U. S. is owned by The Texas Company and U. S. Rubber Company; Goodrich-Gulf represents a partnership of B. F. Goodrich Chemical Company and Gulf Oil Corporation.

Salt Lake Refining Company has plans for construction of a 6000-barrel-a-day catalytic-reforming unit. The Standard Oil Company of California subsidiary has set Sepetmber, 1957, as a tentative completion date. The unit will be installed at the company's 28,000-barrel-a-day Salt Lake City refinery.

Cary Chemicals, Inc., will begin construction next spring on a 12-million-pound-a-year PVC resin plant at Flemington, N. J. Design and construction of the new plant will be done by Scientific Design Company, Inc., and its subsidiary SD Plants, Inc. It will employ Scientific Design's suspension polymerization process.

The Texas Company has gone on stream at its Los Angeles refinery with the first furfural refining unit for the treatment of virgin gas-oil cracking stock. The new unit has a daily capacity of 25,000 barrels, yielding 94 percent raffinate, which is charged to the refinery's fluid catalytic-cracking plant. Long used for refining lubricating oils, the furfural process decreases the sulfur content of virgin gas oil, extracts metal contaminants and reduces the aromatics content. The new unit at Los Angeles uses centrifugal extractors instead of packed towers.

Societe Condor Per l'Industria Petrolifera e Chimica has gone into operation with a new catalytic-reforming unit at its Milan refinery. The new Italian unit, a 5500-barrel-a-day Platformer, is designed to produce a 96-plus leaded-octane gasoline blending stock. It was designed and licensed by Universal Oil Products Company, and engineered and erected by Compagnie Tecnica Petroli (CTIP). The equipment was made and erected by Italian firms, under the supervision of CTIP and CONDOR's technical staff.

Gulf Natural Gas Corporation has completed a new $3-million natural-gasoline plant at Oil City, La. Capacity of the plant is 20 Mmcf. a day.

Texas Asphalt & Refining Company has gone on stream with a new 2000-barrel-a-day refinery at Pasadena, Texas. Built at a cost of some $4 million, the plant later will be expanded to an ultimate capacity of 5000 barrels a day.

Firestone Tire & Rubber Company has gone into production at its Akron plant with new facilities which will increase synthetic-rubber output there to 40,000 tons a year from its previous rate of 30,000 tons.

Meanwhile at Lake Charles, the company is planning a 27-percent boost in synthetic-rubber production with completion of another expansion in December.

The expansion at Lake Charles will add 40,000 tons a year of capacity to that

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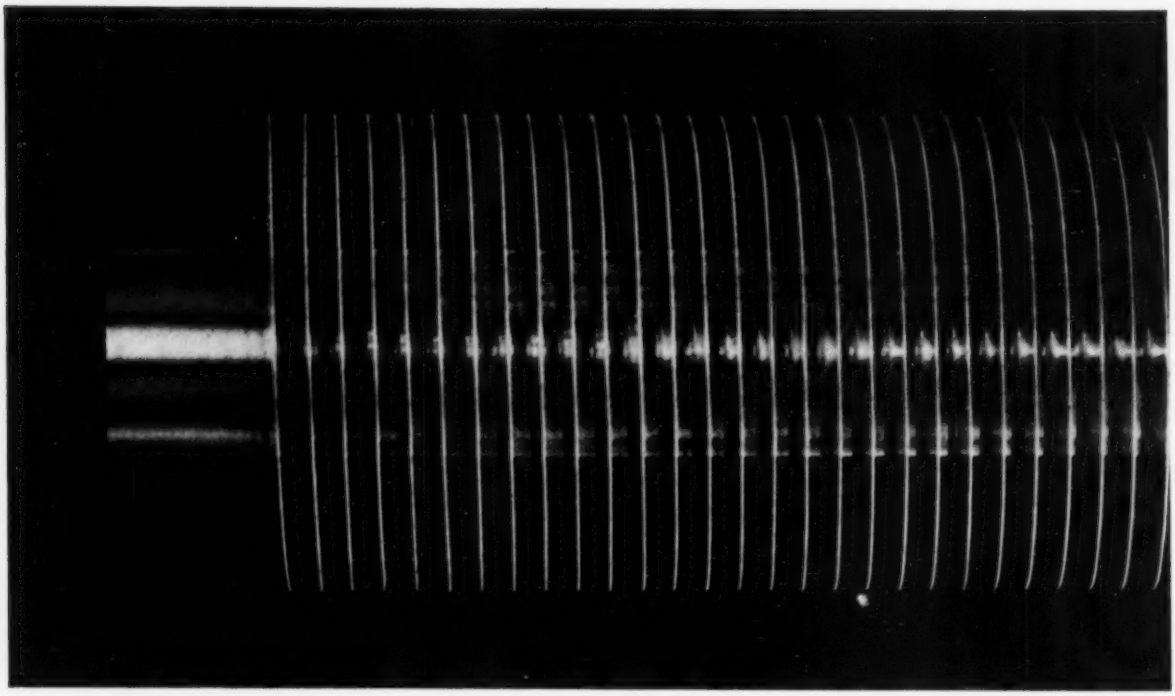

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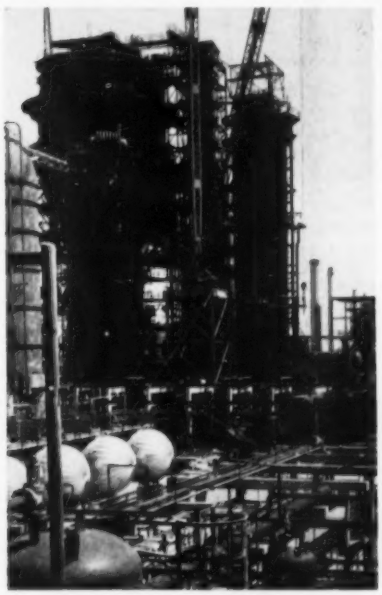
plant, giving it a rated capacity of 190,000 tons. When purchased from the government a little more than a year ago, its capacity was 99,600 tons.

The Lake Charles plant is now producing rubber at a rate in excess of this 150,000-ton-a-year design capacity.

Reflecting its latest expansion at Lake Charles, Firestone will have a combined capacity of 230,000 tons by the end of 1956. The synthetic plants at Akron and Lake Charles has a combined capacity of 129,600 tons when they were acquired from the government in April 1955.

In addition to its expansion of synthetic capacity, Firestone has plans for a petrochemical center at Orange, to include a plant for making 40,000 tons a year of butadiene.



A Refinery Being Formed—

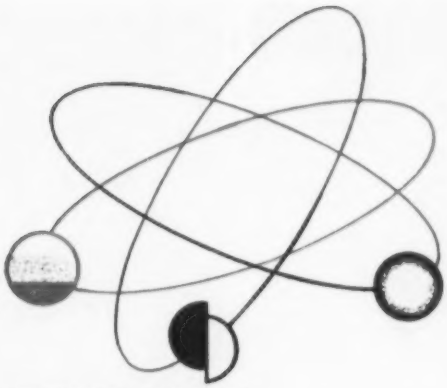
Scheduled to begin operations late this year, this is the 130,000-barrel-a-day refinery Tidewater Oil Company is building near Wilmington, Delaware. The tall vessels in the background are part of the refinery's Orthoflow fluid catalytic cracker. It is the furtherest advanced of the plant's major processing units and the world's largest with a daily capacity of 102,000 barrels.

Government of India will have a two-thirds share in the projected refinery to process Assam's new-found oil resources. Also sharing in the venture will be Assam Oil Company, Ltd.

The location of the refinery is still undecided. Members of Parliament from Assam are pressing for the refinery to be built in that area. And the Bihar Chamber of Commerce is seeking the plant for Barauni in northern Bihar.

Government spokesmen have pointed out that economic factors will have to determine the location of the plant. It is the view of Assam Oil Company that the refinery should be at Calcutta, near the areas of consumption.

At present, Assam Oil's refinery at Digboi is operating below capacity, because of a lack of local demand for finished



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Who's Building . . .

products and a shortage of rail and pipeline facilities to transport the refinery's full output to points of consumption.

The refinery at Digboi has a daily capacity of 5750 barrels. The company is a subsidiary of The Burmah Oil Company, Ltd.

Another refinery also is being considered for India. It would be at Bhavnager on the Gulf of Cambay. Plans for this refinery, expected to cost about $30 million, were completed several months ago between the government of Saurashtra state and the sponsors of the project, reported to be French.

The Texas Company is taking options on land for its proposed 30,000-barrel-a-day refinery at Anacortes, Wash. The refinery is expected to cost $50 million.

A/S Norske Esso is making progress with its proposal to build a second refinery in Norway. The Ministry of Industry was sent the company's plans to other agencies for further study. The company, an affiliate of Standard Oil Company (New Jersey), is asking permission to build a $30-million refinery in Norway, probably at Skjenerkilen near Oslo. It now operates the country's only refinery, a 1800-barrel-a-day plant at Vallo.

Celanese Corporation of America will increase by 25 percent its facilities at Bishop, Texas, for the production of formaldehyde, methanol, acetaldehyde and certain other organic chemicals. The ex-

Integrated Operation—

This view of the new 35,000-barrel-a-day American Oil Company refinery at Yorktown, Va., shows the integration in process design which allows a group of units to be considered as one while providing maximum flexibility. Designed and constructed by The M. W. Kellogg Company, the group includes atmospheric distillation, vacuum distillation, orthoflow fluid catalytic cracking, gas recovery and catalytic polymerization units. While these units are complete, they are linked together for economy, efficiency and flexibility. In addition, Kellogg is also responsible for the construction of most offsite facilities. This major group of process units is scheduled to go on stream in November.

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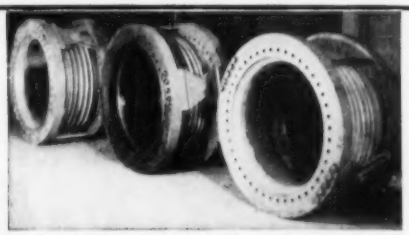

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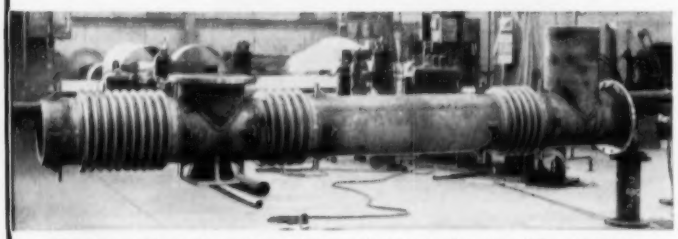

Complex stainless steel assembly of piping and joints absorbing four different motions

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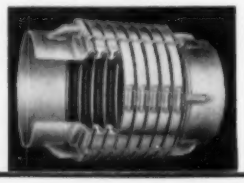

Regardless of size or degree of complexity of the joint involved, ADSCO applies its vast engineering experience to every piping problem presented to it. The help ADSCO provides not only makes the customer's piping react the way it should but also saves money in both installation and maintenance costs. Next time consult ADSCO, a leader in the development of maintenance-free packless expansion joints.

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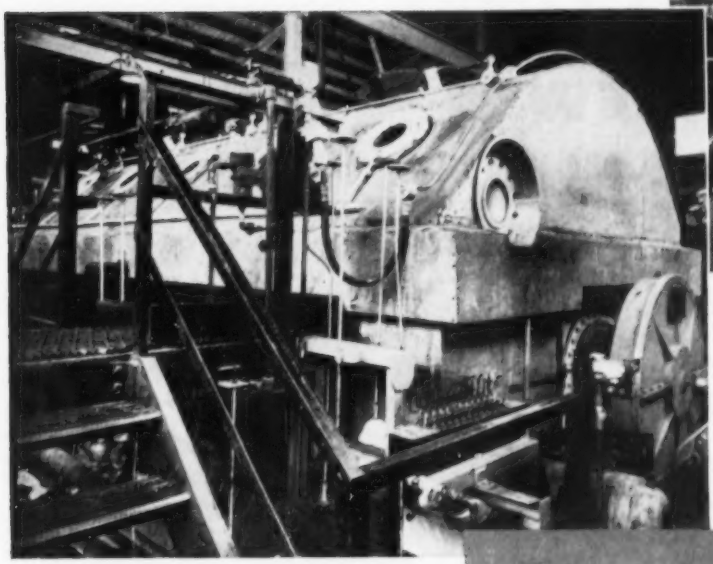
CB&I built the reactor-regenerator and catalyst hoppers for the UOP fluid catalyst cracking unit shown above at the Rock Island Refinery Corp., Zionsville, Indiana, refinery.



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pansion is expected to be completed in 1957. The plant's new facilities will make it the world's largest producer of formaldehyde.

Canadian Oil Refineries, Ltd., has awarded the contract for engineering and construction of two new process units for its refinery at Sarnia, Ont. The units, a 4400-barrel-a-day Platformer and a 3600-barrel-a-day Udex unit, will be installed by The Fluor Corporation of Canada, Ltd. Construction on the $3-million project will be started this fall, with completion scheduled for early summer, 1957. In addition to providing high-octane gasoline, the units will turn out benzene, toluene and xylene.

American Cyanamid Company will begin breaking ground in December for construction of a Florida plant to produce synthetic fiber from the acrylonitrile produced at the company's Fortier plant near Avondale, La. The new plant, at Pensacola, will be built for an annual production of 27 million pounds of stable and tow. It is due to be completed in mid-1958.

Syrian Government was expected to announce a decision on the successful bidder for construction of its proposed refinery at Homs.

The government has been wanting a refinery for some time, and has been considering bids from various countries since early this year. It wants a refinery with a daily capacity of 15,000 to 20,000 barrels a day, and parliament has set aside $20 million for the project.

Among the countries submitting bids were the U. S., the United Kingdom, France, the Soviet Union, Czechoslovakia and Rumania.

According to reports, Russia was ready to build a refinery any place the government wanted it. Financial arrangements were not known, but it was understood that the Russian price would be very low.

Another low price was supposed to have been made by Czechoslovakia's Techno-Export. This concern was believed to have submitted a bid 20-percent less than the British tender which was reported at a little more than $15 million.

Twice, oil companies have been mentioned as possible builders of a refinery in Syria.

Iraq Petroleum Company, Ltd., was asked to build a refinery at Banias for Syria's account out of revenue the government receives from the company's pipeline operation. Instead, an agreement was reached, under which the oil company is pledged to furnish Syria about 600,000 tons of crude a year.

Another company, Esso Standard (Near East), Inc., has offered to build a refinery at its own expense. The proposal, to build a 10,000-barrel-a-day plant, has no connection with the projected government plant. But if the offer is accepted, the government is expected to abandon plans for its own refinery.

Humble Oil & Refining Company has awarded the contract for design and construction of the new catalytic-cracking unit to be installed at its Baytown refinery. Foster Wheeler received the contract.

The new unit, a fluid catalytic cracker of special design, will be of the stacked

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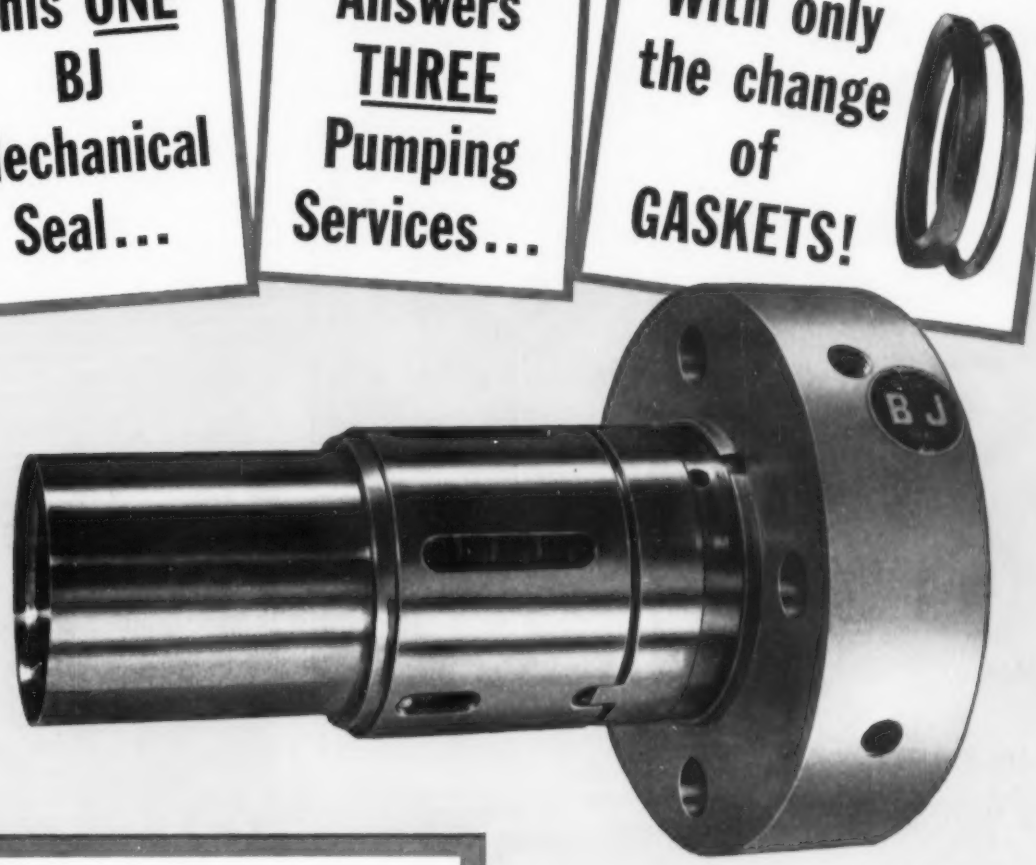

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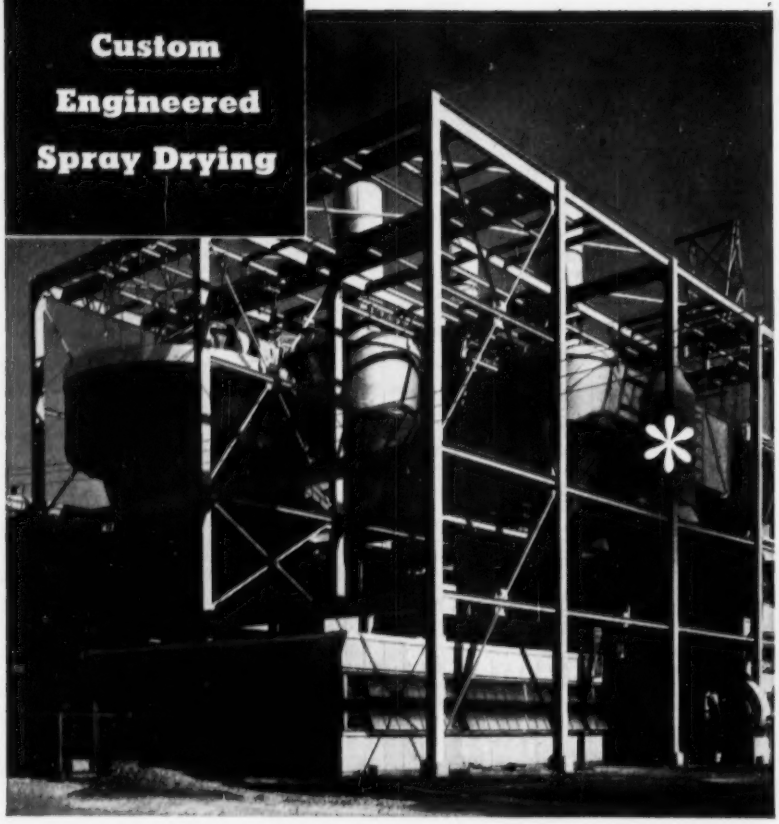

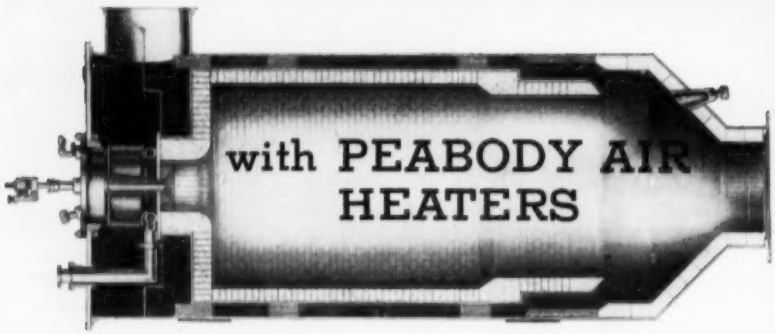

* Peabody Direct Fired Air Heaters have wide acceptance with various spray dryer designers and involving such products as petroleum catalysts, chemicals, minerals, detergents, and foods. A typical application at the Davison Chemical Company, Division of W. R. Grace & Co., Baltimore, Maryland, uses a Peabody Air Heater in conjunction with a Swenson spray dryer, a product of the Swenson Evaporator Company, Division of Whiting Corporation, Harvey, Illinois. The heater fires natural gas fuel at a maximum firing rate of approximately 85,000,000 BTU/hr. to spray dry silica gel catalyst for the petroleum refining industry.

Every Peabody Air Heater is job-engineered and custom-built to individual specifications. Years of experience and a wide variety of applications throughout the world, enable Peabody to offer assured performance for heat releases from 1 million to 300 million BTU/hr. and for furnace pressures from atmospheric to 10 or more atmospheres. Write for Bulletin 600-A.

PEABODY ENGINEERING CORPORATION

232 MADISON AVENUE, NEW YORK 16, N. Y.

OFFICES IN PRINCIPAL CITIES

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6-141

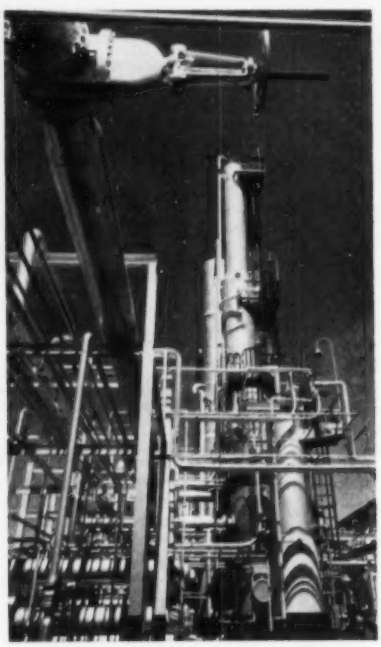
Who's Building. . .

type with the stripper vessel above the regenerator in the same structural setting.

It has a design capacity of 55,000 barrels a day of total feed and is probably one of the highest-capacity stacked units in the industry. The refinery's two existing catalytic crackers, also fluid units, are of similar capacity.

Tidewater Oil Company has been granted a certificate of necessity allowing rapid amortization on 50 percent of $7.6 million and 65 percent on $9.1 million spent on an expansion and modernization of its 114,000-barrel-a-day refinery at Avon, Calif.

The company is building a 42,000-barrel-a-day fluid coking unit, a 47,500-barrel-a-day fluid catalytic cracker and a hydrodesulfurization unit with a daily capacity of 24,000 barrels. Due for completion this fall, the project is being handled by Bechtel Corporation.

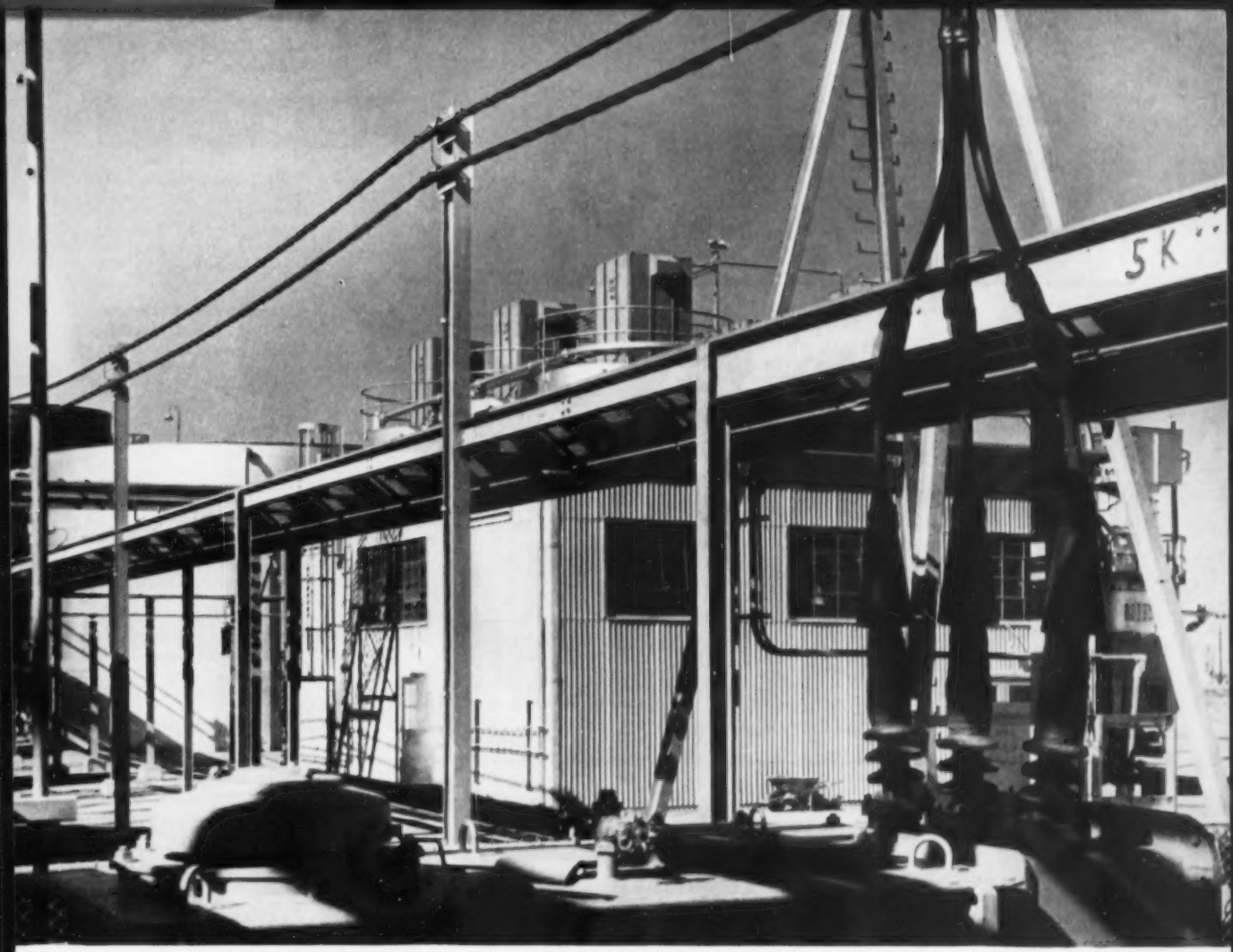


Reformer in Operation—

The British American Oil Company, Ltd., has gone on stream with its new catalytic reformer at Montreal East. The unit, completed earlier this year, has been undergoing extensive tests. Built for a daily capacity of 13,000 barrels, it is the newest addition to the 45,000-barrel-a-day Canadian refinery.

Sinclair Refining Company will install a new crude-recovery unit at its 22,000-barrel-a-day Corpus Christi, Texas, refinery. Engineering and construction will be handled by Telliepsen Petro-Chem Constructors. The project will be started late this year.

Compagnie de Raffinage Shell-Berre, a member of the Royal Dutch/Shell Group, has joined several other companies in organizing a company to build an 80,000-barrel-a-day refinery in France. The new refinery will be at Strasbourg on



Heads above the crowd, Anaconda Aerial Cable makes a fast, neat, low-cost installation at oil refinery.

How to handle high voltage with a low overhead

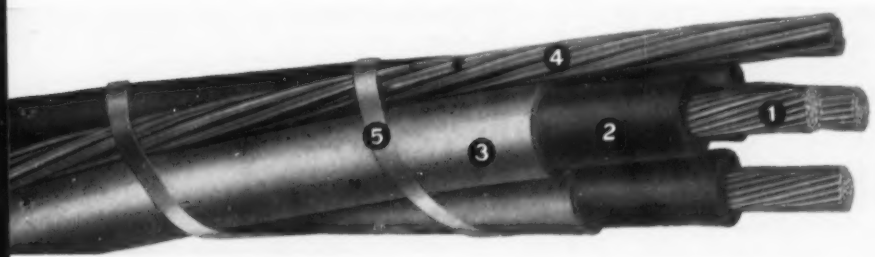
Anaconda Aerial Cable goes over crowded areas... gives highly reliable service at low cost.

Pipes and other underground structures often make installation of ducts or buried cable costly and difficult. The ideal answer: Anaconda Aerial Cable.

See how easy it is to install—no ducts, crossarms or insulators are needed. Even if underground obstructions are not a factor, this rugged neoprene-jacketed cable costs much less than buried systems.

Neoprene jacket resists weather and abrasion. Special Anaconda Type AB butyl high-voltage insulation gives extra protection against ozone, heat, moisture and fumes.

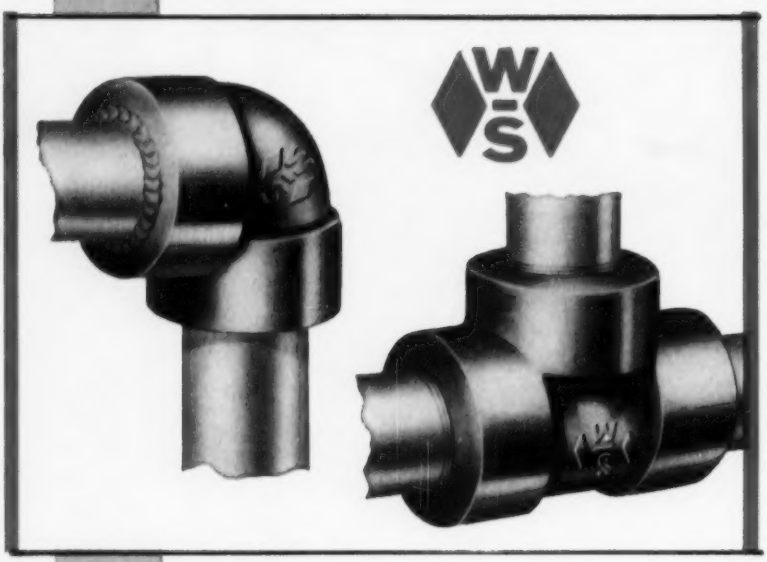
For the full story, call the Man from Anaconda or your nearest Anaconda distributor. For information on Aerial Cable write to: Anaconda Wire & Cable Company, 25 Broadway, New York 4, N. Y. 56287



1. Conductors—copper or aluminum
2. Ozone-, moisture- and heat-resistant butyl insulation
3. Neoprene weather-resistant jacket
4. Messenger
5. Binder Tape

ASK THE MAN FROM **ANACONDA®**
FOR **AERIAL CABLE**

2 Safe Ways to PROTECT Pressure Piping...



W-S SCREW-END and SOCKET-WELDING FORGED STEEL FITTINGS

Pipe joints are potential trouble spots in high pressure piping systems. Change in direction of flow causes turbulence, erosion and vibration. Watson-Stillman fittings are made to absorb this type of punishment. They're drop-forged for strength and toughness and safety-factor designed for the protection of your piping.

Choose between a welded piping system and a screwed one to suit your needs. Then choose W-S Screw-End or Socket-Welding Fittings to join your pipe. They're available in sizes ⅛" to 4" for piping up to 6000 lb. W.O.G. class. For high temperature or corrosive service you can get W-S Forged Stainless and Alloy Steel Fittings, too. Send today for our informative catalogs.

W-S FITTINGS DIVISION

H. K. PORTER COMPANY, INC.

Roselle, New Jersey

Who's Building...

the Rhine River. Participants in the company, besides Shell, include Caltex, Esso Standard, Mobil Oil Francaise, Petroles B. P., Francaise des Petroles, Petrofina and some German companies. Cost of the refinery is expected to run about $70 million.

Wyandotte Chemicals Corporation will build an $8-million ethylene-oxide plant at Baton Rouge. This will be the first time Shell Development Company's ethylene-oxide process has been used in the U. S.

Construction of the 60-million-pound-a-year plant will be started in January, and Wyandotte expects to have it on stream by the end of 1957. The Lummus Company is handling construction on the project.

Although this will be the first use of the process in the U. S., it also is going to be used by a Shell affiliate, Petro-Chemicals, Ltd., at its Partington, England, plant. The British installation will be complete in mid-1958.

Continental Carbon Company has started up a 25-million-pound-a-year plant for the production of furnace-type carbon black at Eunice, N. M.

Warren Petroleum Corporation is planning a petrochemical plant for the Houston area. Although no plans have been announced, estimates on the cost of the project have run as high as $5 million. The company recently acquired a large tract of industrial property near the Texas Butadiene & Chemical Corporation plant.

Chemstrand, Ltd., will build a plant in northern Ireland for the manufacture of acrylic fiber. At Coleraine, the plant is scheduled to be in production by early 1959. Engineering and design work has been started, and the first phase of construction is expected to cost about $10 million. The company is a wholly-owned subsidiary of Chemstrand Corporation, a Decatur, Ala., concern.

Standard Oil Company of Texas has awarded the contract for design, engineering and construction of a new catalytic-cracking unit for its refinery at El Paso. The unit, a 27,000-barrel-a-day fluid cracker, will be installed by The Fluor Corporation, Ltd.

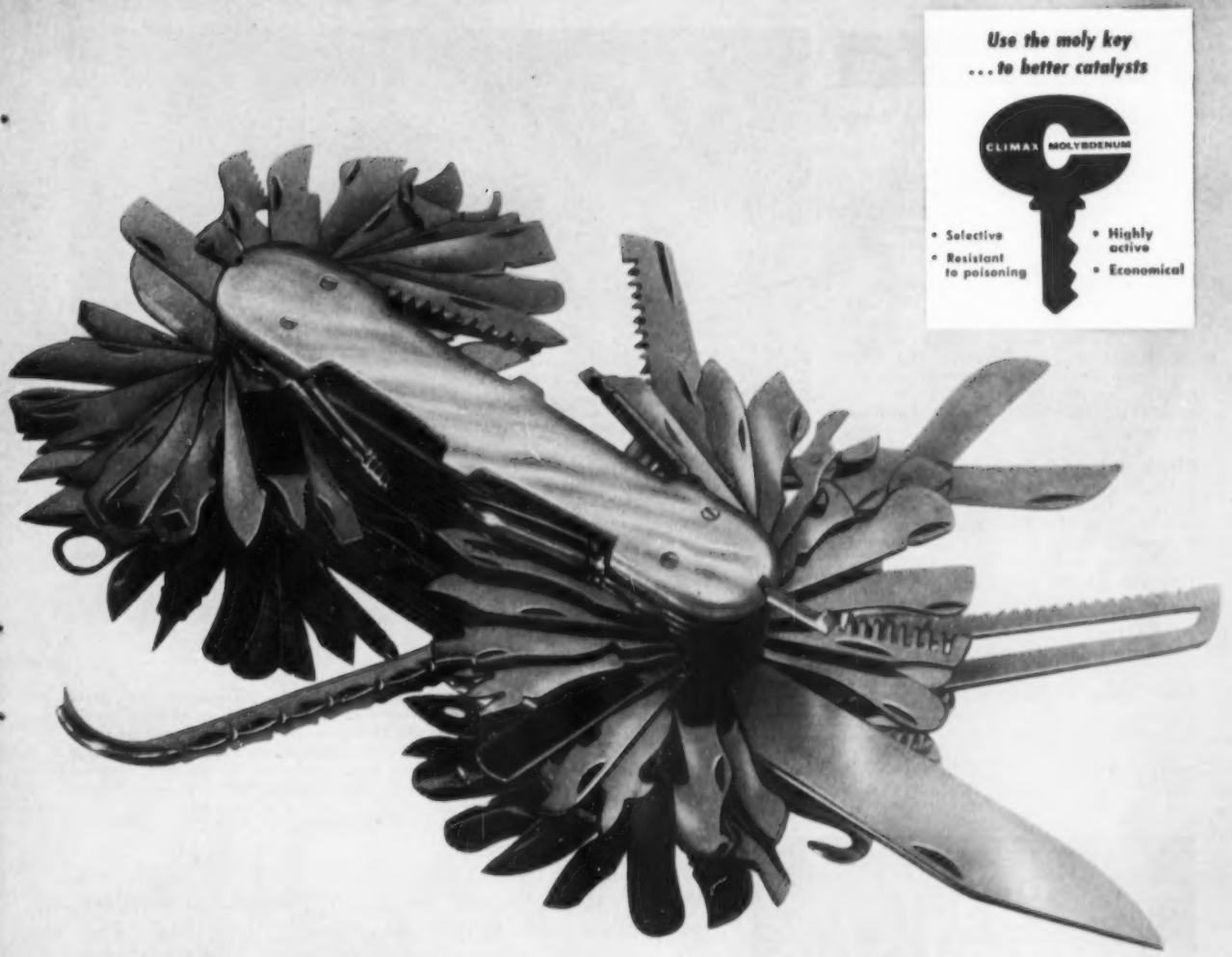
Construction will be started in December, with the new unit scheduled to go on stream in September 1957. The contract also includes installation of fractionation, gas-recovery, caustic-treating, compression and distillation facilities at El Paso.

Canadian Industries, Ltd., will complete a 200-ton-a-day anhydrous-ammonia plant late this year at Millhaven, Ont. Built to use a process licensed by Texaco Development Corporation, the new plant will cost about $8 million. An engineering and construction contract is held by Girdler Corporation of Canada, Ltd.

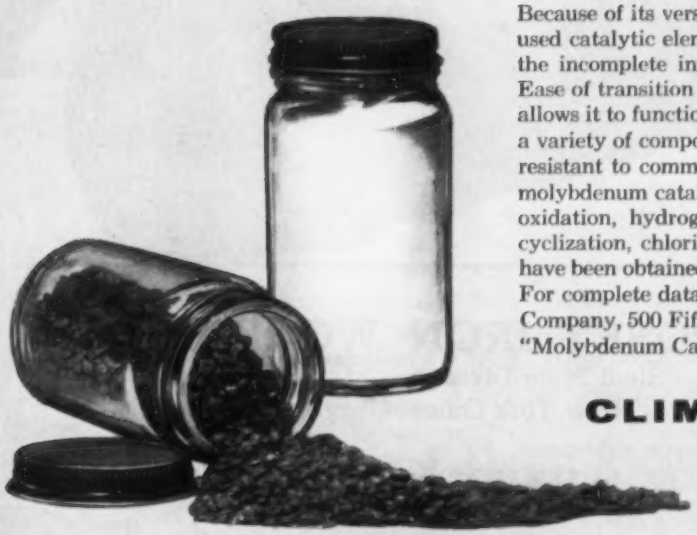
Esso Standard Oil Company has two major additions under construction for its refinery at Linden, N. J.

Due for completion in mid-1957 is a 20,000-barrel-a-day Powerformer. The affiliated Esso Research and Engineering Company, which is licensing the unit, also

For more data on advertised products, use Readers' Service Cards, last page.



Moly catalysts are versatile



Because of its versatility, molybdenum is one of the most widely used catalytic elements. As a transition element, it has the incomplete inner shell of electrons needed for catalytic activity. Ease of transition from one to another of its six valence states allows it to function readily as an electron acceptor or donor. It forms a variety of compounds in all valence states, most of them resistant to common catalytic poisons. Commercially, molybdenum catalysts are used in seven types of reactions: oxidation, hydrogenation, dehydrogenation, isomerization, cyclization, chlorination and condensation. Promising results have been obtained in dehydration, polymerization and alkylation. For complete data write Department 25, Climax Molybdenum Company, 500 Fifth Ave., New York 36, N. Y. for our bulletin, "Molybdenum Catalysts for Industrial Applications."

CLIMAX MOLYBDENUM

Courtesy of Hoffritz for Cutlery, 331 Madison Avenue, New York

Who's Building. . .

is handling the engineering, and Foster Wheeler Corporation is in charge of construction.

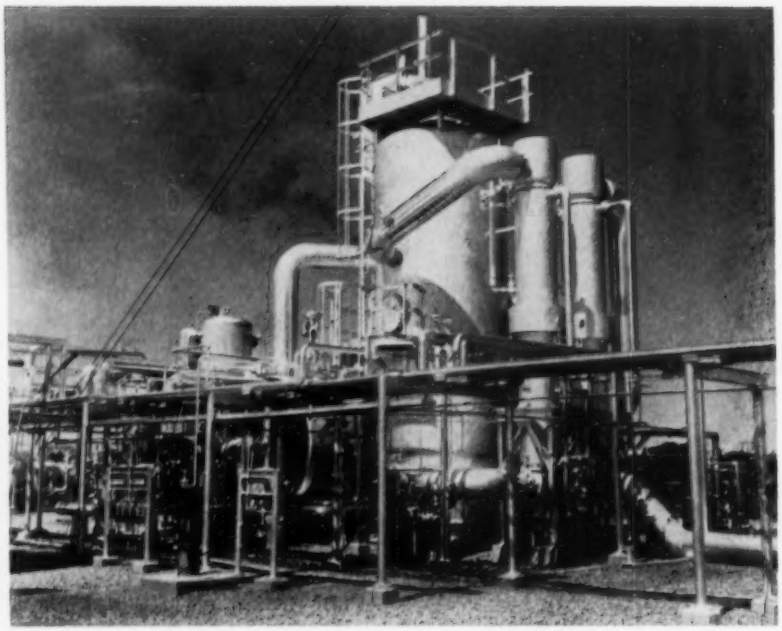
The other unit, an alkylation plant, is scheduled for completion late next year. It is being built for a daily capacity of 5500 barrels. The Ralph M. Parson Company is contractor for both the engineering and construction work.

And at Everett, Mass., the company is installing another Powerformer. This unit, which also is scheduled to go on stream in mid-1957, will have a capacity of 7200 barrels a day. Esso Research and Engineering is doing the engineering on this project too, and Badger Manufacturing Company is contractor for the construction project.

Clark Oil and Refining Company is planning a major expansion of its refinery at Chicago. Scheduled for completion in 1958, the $5-million project will increase capacity of the 21,000-barrel-a-day refinery to 30,000 barrels a day.

It will include the installation of new vacuum, crude-heating, gas-recovery, alkylation and catalytic-cracking facilities. Universal Oil Products Company will license several of the processes to be used.

The Texas Company is planning an expansion which will include a 86,000-barrel-a-day crude-distillation unit for its refinery at Port Arthur. The refinery now has a daily capacity of 210,000 barrels. Due to begin late this year, the project

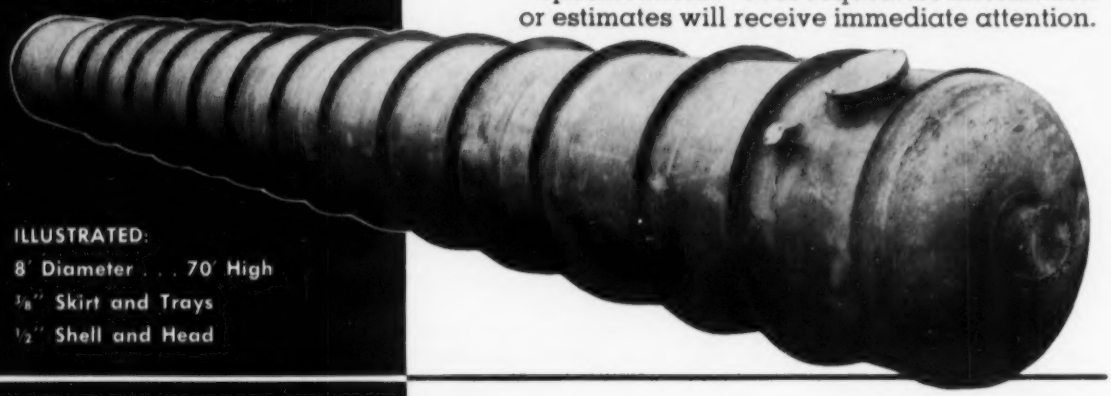


Montana Sulfur Plant in Operation—

Montana Sulphur & Chemical Company has put on stream a new sulfur-manufacturing plant at Billings, Mont. Built for a daily capacity of 40 long tons, the plant will produce high-grade sulfur from hydrogen-sulphide gases obtained from the Billings refineries of The Carter Oil Company and Continental Oil Company. It was designed and engineered by Badger Manufacturing Company and cost almost $500,000. In addition to the new sulfur plant, the chemical company has erected a hydrogen-sulphide-recovery plant. It was engineered by Proctor Engineering Company.

POSEY FRACTIONATING TOWERS

Posey's experience in producing welded steel plate structures dates back to 1910 . . . so Posey has the experience as well as the facilities to design and fabricate almost any type of structure required by your industry. Trust Posey to build to your most rigid specifications. Your request for information or estimates will receive immediate attention.



ILLUSTRATED:
8' Diameter . . . 70' High
3/8" Skirt and Trays
1/2" Shell and Head

TANKS • PRESSURE VESSELS
STEEL PLATE FABRICATION
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POSEY IRON WORKS, INC.
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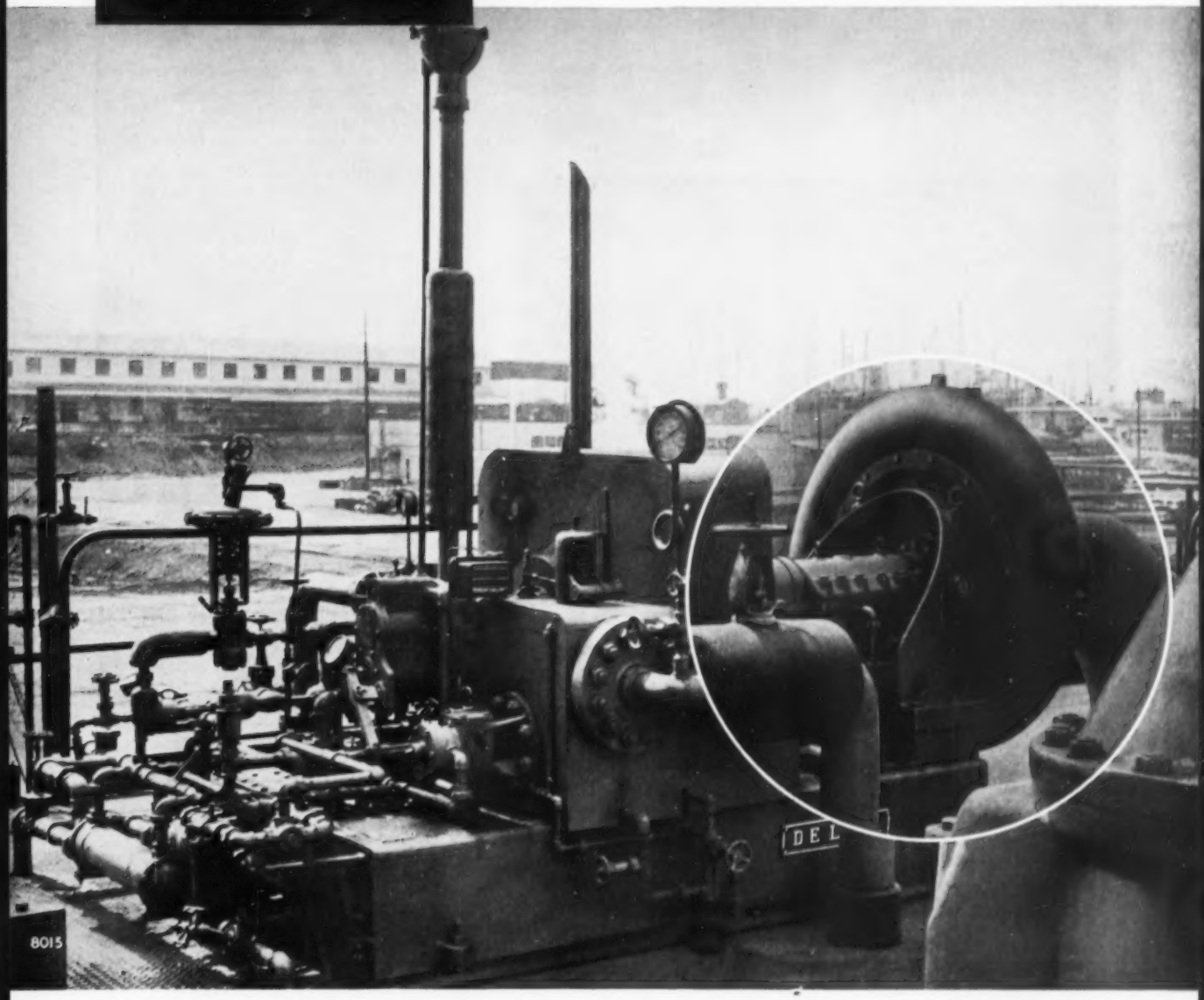
DE LAVAL
CENTRIFUGAL
BLOWER

controls air in cat cracker at Standard Oil of California



This De Laval centrifugal blower, selected by the Fluor Corporation, is on stream at the Standard Oil Company of California's new cat cracker in El Segundo. For control air service, this blower delivers 9,500 cfm; inlet pressure is 15.4 psig and discharge pressure 19.4 psig. The blower is driven by a De Laval 220 brake horsepower MCP Turbine operating at 300 psig with a temperature of 650 F; it has all labyrinth shaft packing for high back pressure service.

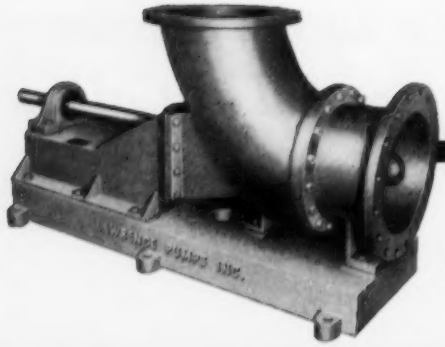
In addition to single stage designs, De Laval makes a complete line of equipment for all refinery services, including multi-stage compressors driven by De Laval multi-stage turbines for condensing, non-condensing and automatic extraction applications.

Send for new Bulletin 0504

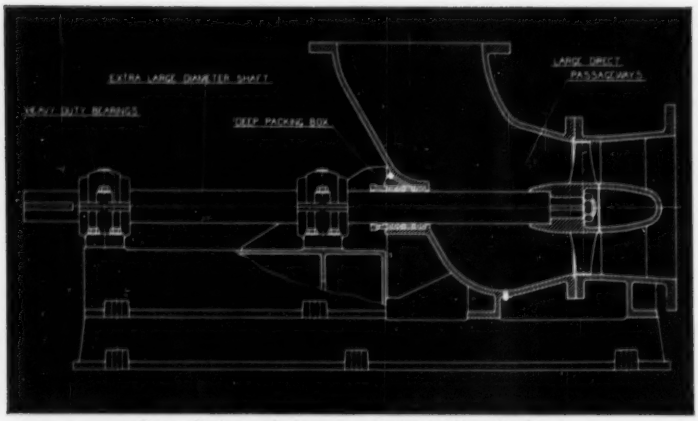
DE LAVAL *Centrifugal Blowers*

DE LAVAL STEAM TURBINE COMPANY
811 Nottingham Way, Trenton 2, New Jersey

DL 389



Lawrence 24" Horizontal Circulating Pump of Nickel Alloy Construction



Cross Section of Lawrence Horizontal Propeller Pump

PROPELLER PUMPS
FOR THE
CHEMICAL and PROCESS INDUSTRIES

Lawrence Propeller or Axial Flow Pumps are widely used to circulate large volumes of liquid or slurry against low heads as in evaporators, crystallizers, etc. This type of pump is particularly well adapted for circulating service because of its simplicity, high efficiency, and low first cost. The flow can be arranged in either direction and the casing turned to any position desired to serve as an elbow. The capacity can be closely regulated by varying the speed—very important in crystallization processes where a uniform velocity must be maintained.

Lawrence Propeller Pumps are made of the metals and alloys best suited for their ability to resist the corrosive and abrasive action of the liquid pumped.

Write for Bulletin 203-6 for summary of acid and chemical pump data.

LAWRENCE PUMPS INC.

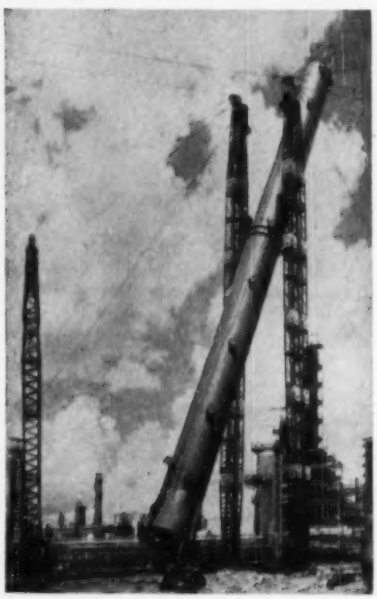
371 MARKET STREET, LAWRENCE, MASS.

Who's Building . . .

also will give the refinery a new catalytic-cracking unit with a capacity of 60,000 barrels a day and increase the refinery's alkylation capacity by 2000 barrels a day. Construction is expected to take about a year to complete.

Magnolia Petroleum Company has a gasoline plant under construction in Kansas which will process 30 Mmcf. of natural gas a day for use inside the state; so it will not be subject to Federal Power Commission controls.

At Attica, near Wichita, the plant will extract 21,000 gallons of natural gasoline and 26,000 gallons of propane and butane a day. It will be owned by 29 producers in the area, with Magnolia serving as operator.



One-Piece Skyscraper

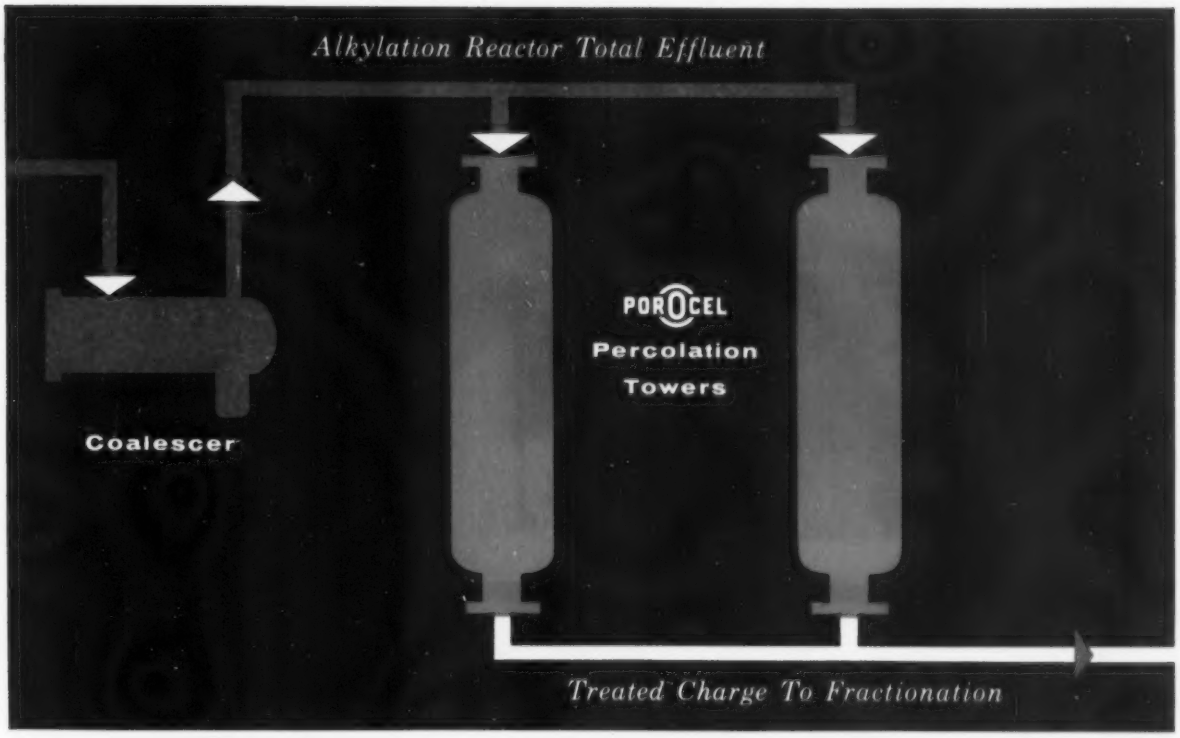
A fractionating tower—more than 200-feet-high—is raised above the Esso Standard Oil Company at Baton Rouge. Built by Delta Tank Manufacturing Company, the column is believed to be the largest ever built. It weighs 410,000 pounds, has an 11-foot, 8-inch diameter, was fabricated from inch-thick steel plate and dwarfed the four railroad flatcars on which it was shipped to the refinery.

El Paso Natural Gas Products Company has Southwestern Engineering Company handling engineering and construction on its 9000-barrel-a-day refinery now under construction at Gallup, N. M.

The new refinery, due for completion in the fall of 1957, is expected to cost $10 million. Equipment will include crude and vacuum distillation facilities, a catalytic cracker and catalytic reformer and an alkylation unit.

Compania Petrolera Shell de Cuba, S. A., is reaching the final stages of construction on its 25,000-barrel-a-day refinery at Havana. The project, due for completion in November, is being handled by Bechtel Corporation.

For more data on advertised products, use Readers' Service Cards, last page.



POROCEL adsorbent helps increase capacity, reduce maintenance costs of Alkylation unit

Employed in the new effluent treating technique developed jointly by DX-Sunray Oil Co., and M. W. Kellogg Co., Porocel—M & C's versatile sorptive bauxite—plays an important role in DX-Sunray's Alkylation Unit at West Tulsa.

Straightforward Method—Total H_2SO_4 reactor effluent is handled in a simple 2-tower percolation system—one tower on stream while Porocel in the other undergoes unique in-place regeneration.

Trouble-Free Operation . . . Increased Capacity—Porocel preferentially removes more than 99% of acid and esters as compared with about 65% removal obtained in conventional caustic and water wash systems. This *virtually eliminates* corrosion and fouling in fractionating equipment, provides *sound protection* against maintenance troubles, and permits pushing the unit to higher capacity.

Long Life—In addition to showing high cycle life, Porocel charge in the West Tulsa unit has been in use for an extended period of time, and cumulative life is in excess of 150 barrels of throughput per pound.

Other credits include: improved tetraethyl lead susceptibility; reduced H_2SO_4 consumption; elimination of corrosion inhibitors in the recovery section.

There's always a *new place* for versatile, low-cost M & C sorptive minerals to improve the quality and cut the processing costs of petroleum products. The coupon will put us to work for *you*.

ATTAPULGUS **POROCEL PRODUCTS** *from*

MINERALS & CHEMICALS CORPORATION OF AMERICA
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ALWAYS A BETTER WAY...

MINERALS & CHEMICALS CORPORATION OF AMERICA
14 Essex Turnpike, Menlo Park, N. J.
Please send me without obligation:

- ☐ More data (with samples) on Porocel in H_2SO_4 Alkylation service
- ☐ Technical opinion on applying M & C sorptive minerals as follows

_____

_____

name_____ title_____

company_____

address_____

city_____ zone_____ state_____

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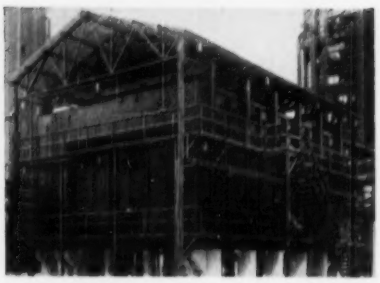
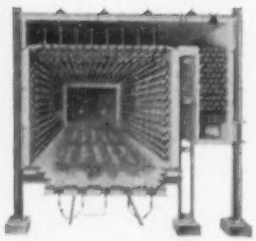
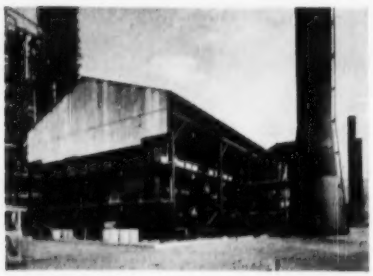
LUMMUS

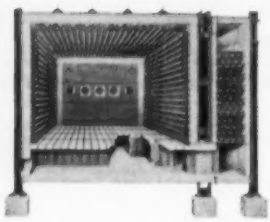
OIL HEATER DIVISION
385 Madison Avenue, New York 17, N. Y.



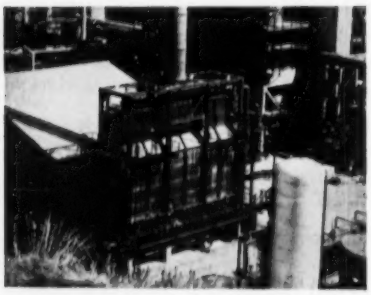


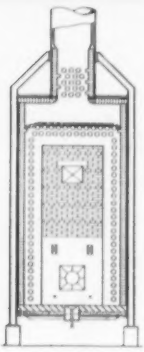
Lummus Standard Oil Heaters are made in two basic types. The up-take heater, illustrated at the left, conducts the products of combustion upward from the entire heating chamber at low and uniform levels of velocity.





The down-take heater, illustrated at the left, is suitable for service where products of combustion would contain corrosive elements or solid matter. It draws hot gases downward from the combustion chamber through the diffusion baffles. Both types of Lummus Standard Heaters are adaptable for multi-coil or multi-stage heating.





The Economy Heater, illustrated at the left, finds wide application in smaller refineries where the investment necessary for extensive maintenance platforms and roofing is not justified. The flexibility and variety of capacities available with multi-coil and multi-stage settings can be obtained with Lummus-Built Heaters in the same manner as with the larger Standard units.

Lummus Standard Oil Heaters and Lummus-Built Heaters are the answer to the vital problem of supplying process heat in any required amount for petroleum refineries, chemical and petro-chemical plants. Single Lummus Heaters are operating at continuous heat absorptions ranging from 100,000 to 300,000,000 BTU per hour. Lummus has designed and installed heaters for use with every major process.

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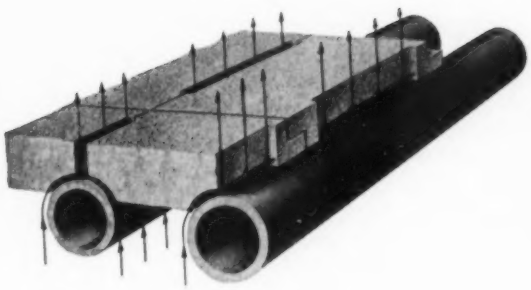
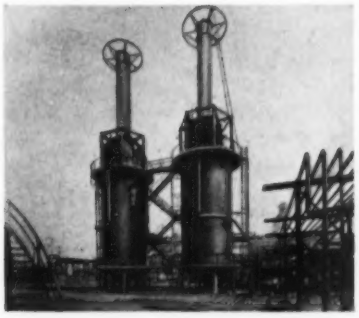
LUMMUS

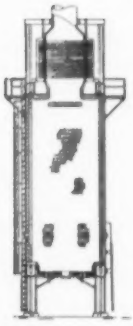
OIL HEATER DIVISION
385 Madison Avenue, New York 17, N. Y.



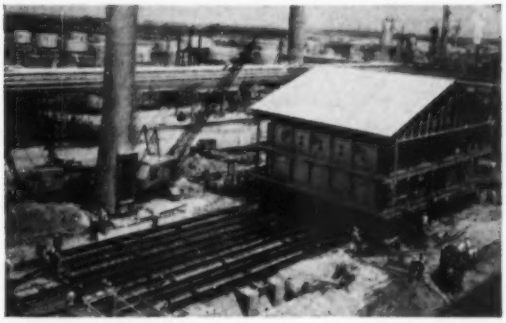
The patented gas diffusion baffle arrangement shown at the left is characteristic of Lummus furnaces. This arrangement creates a draft resistance or dampering effect which assures uniform evacuation of the products of combustion over the entire ceiling area of the combustion chamber.

Benefits obtained by the use of the slotted refractory baffle tile include high velocity gas flow over the shielded upper row of roof tubes—with consequent high convection heat pick-up—and re-radiated heat from the under side of the tile to the upper side of the bottom row of roof tubes.





Lummus-Built Heaters incorporate the same material, mechanical and operating advantages of the Lummus Standard Oil Heaters but are built along the more simplified and economical lines possible with their smaller size. The Lummus Vertical Tube Heater, illustrated at the left, for milder heat requirements, is especially designed for limited space installation.



The portable heater, left, was built for Magnolia in record time—a mere six weeks downtime compared with the usual five months. It is the height of flexibility and is a smooth-running 100,000,000 BTU per hour heater handling 36,000 B/D of charge stocks—an increase of several thousand barrels over the heater it replaced.

The heaters described above are, of course, Lummus designed. Lummus also has built and will build for you, if requested, counter-parts of all popular types of furnaces used in the petroleum, chemical and petro-chemical industries. Lummus can also build to your specifications any type of specialty heater that a particular production problem calls for. Lummus' 50 years of experience in constructing petroleum and chemical plants lies behind the work of the Oil Heater Division, providing the knowledge necessary to do any job requested by a customer—and to do it right.

BRANCH OFFICES — Chicago: 600 South Michigan Ave., Chicago 5, Illinois • Venezuela: Compania Anonima Venezolana Lummus, Edificio "Las Grandillas", Esquina Las Gradillas, Caracas, Venezuela • Canada: 455 Craig St. West, Montreal

For more data on advertised products, use Readers' Service Cards, last page.

Streamline Your Office Work

Here is a clerical work simplification program that will eliminate waste of time, materials, equipment, space and human energy.

William E. Sexton
Continental Oil Company
Houston

CONTINENTAL OIL COMPANY'S clerical work simplification program is designed to train Controller's department employes in practical work simplification so they may analyze their own duties and develop improvements.

The need for streamlining office work was brought about by:

- Considerable growth in clerical force.
- Change from "management by hunch" to scientific management.
- Desire to seek "the best way possible."
- Greater responsibilities to management to provide more and better information at reduced costs.

The first step was to prepare manuals and card chart visuals and to cover the complete program briefly with departmental management people. Following this presentation, assistant controllers held group meetings for all employes in the department at which the philosophy of work simplification was explained. It was pointed out there would be two training programs, one for first line supervisors or unit heads and another for other department personnel.

The unit head conferences consist of 18 hours of class and laboratory work over a six-week period. These conferences are usually limited in size to eight conferees. During analysis sessions there is a further subdivision into groups of four conferees.

Abbreviated conferences for other Controller's department employes consist of seven hours of class and laboratory work with approximately seven hours of assignment work. They are usually limited to 16 conferees, and during analysis sessions, into groups of four conferees.

The conferences. The unit head conferences are divided into seven sessions:

1. Introduction—The Work Distribution Chart, Its Construction and Use—In this session the philosophy, reasons, and need for the program are explained. Also the mechanics of preparing the work distribution chart are explained (3½ hours).

2. Analysis of the Work Distribution Chart. In this session the basic ideas or principles involved in analyzing such charts are explained, after which conferees are divided into groups of four to analyze each conferee's sample chart (3½ hours).

3. The Process Chart, Its Construction and Use—The mechanics of preparing the chart are explained and conferees given sample problems on which to prepare a process chart. Flow charts and their usages are discussed briefly along with principles involved in analyzing process charts. At the end of the session, the usage of the work count is explained (2 hours).

4. Analysis of the Process Chart (3 hours).

5. Selling the Idea (1 hour).

6. Verbal Presentation of the Idea (3½ hours).

7. Reproduction Processes and Summary (1½ hours).

All sessions are held during office hours.

The abbreviated conferences of seven hours of class and laboratory work are patterned somewhat the same as the unit head conferences except major emphasis is on the preparation and analysis of process charts.

These conferences are divided into three sessions:

1. Introduction and Process Charting. This includes such subjects as philosophy of work simplification, explanation of the systematic approach, selecting the job to be improved, how to prepare a process chart, preparing a sample problem in process charting, how to prepare a flow chart, and usage of the work count (3 hours).

2. Group Analysis of Conferees' Process Charts. In this session the discussion of principles for analyzing job details with resultant development of improvements and group participation in analyzing conferees' process charts is included (3 hours).

3. Selling the Idea and Summary. This covers an outline for installing improvements, principles for selling the idea, verbal presentation of an idea by one of the conferees and management view of work simplification (1 hour).

Bases of conferences. There are several bases used in presenting the subject at the conferences.

- First, an attempt is made to make the sessions informal and invite full participation. About 50 percent of the time is devoted to discussions. Comments and criticism are invited in order to improve subsequent sessions.
- Second, stress is laid on the fact that these are training conferences which furnish the tools for simplifying work and that through use of these tools each participant is able to improve his own work much better than someone who is not familiar with it. Participants are taught to gather, organize and interpret facts

DO *Warm* days

AND *Cool* nights . . .

"SEE-SAW" THE PEP OUT OF YOUR MOTOR FUEL?

BLENDING WARREN NATURAL GASOLINE WITH YOUR PRESENT HIGH QUALITY MOTOR FUEL WILL GIVE IT . . .

Retained Volatility

SO NECESSARY FOR SUPERIOR PERFORMANCE

. . . *In any Season*

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When 3 gauge glasses can cost less than only 1

The money you spend to have a spare and a *spare* spare may save big money in prevented down time.

It works like this:

Order 2 spares for every gauge glass in your plant. Use 1 for routine replacement. Keep 1 for emergency use. This extra spare you buy now costs nothing extra because you'll buy one eventually, anyhow. By stocking ahead, you protect yourself. Free insurance, really.

Remember: "ONE FOR THE GAUGE AND TWO FOR THE SHELF." And always specify hard-to-break CORNING®, PYREX® and MACBETH® gauge glasses. It's the economical way.

CORNING INDUSTRIAL GLASSWARE FOR EVERY JOB

Application	Recommended Product
Normal Conditions (Up to 100 p.s.i.)	CORNING brand standard gauge glasses
Higher temperatures	PYREX brand high-pressure gauge glasses
Higher pressures	PYREX brand heavy-wall gauge glasses
Extra visibility	PYREX brand red-line gauge glasses
Heavy-duty service	MACBETH brand flat gauge glasses
Viewing inside furnaces, reactors, pressure vessels, etc.	PYREX brand sight glasses
Lubrication inspection	PYREX brand lubricator glasses
Visible discharge devices	PYREX brand oil cup glasses

CORNING GLASS WORKS
Corning, New York

Corning means research in Glass

and submit suggestions for improvement.

• Third, this definition for work simplification is used:

"The organized application of common sense systematically applied to eliminate waste of time, materials, equipment, space, and human energy from our daily tasks."

• Fourth, considerable time is devoted to the ideas behind work simplification. These are worker participation, the one best way, and the systematic approach. In using the systematic approach, these steps are suggested:

A. Select the job to be improved.
B. Record the job details.
C. Analyze the job details.
D. Develop the improvements.
E. Install the new improvements.

• Fifth, the value of the use of the work simplification tools in the future day-to-day jobs is covered. Participants are convinced of the value of a lasting program in enabling them to work smarter, not harder.

• Sixth, the point is stressed that work simplification is not a speedup program and that it is aimed primarily at eliminating waste—waste of human energy and human effort—and that waste can be eliminated by analyzing work and use of common sense, imagination and creative thinking.

Here are the tools used:

Work distribution chart. The first tool, a work distribution chart, is a simple spread sheet showing the activities or those major jobs of an organizational unit and the employe's contribution to each of these activities in time. Purpose of the work distribution chart is to give the supervisor a bird's-eye view of the work going on in his organizational unit. The chart is prepared by combining information from two sources. The first source is the activity list, which shows the major functions of the organizational unit. The second source is the time record of the individual employe.

Process chart. Second tool is the process chart, a graphic presentation of the sequence of all operations, transportation, storage and inspections occurring during a process or procedure. On this chart is recorded all information considered desirable and necessary for analysis. It is continuously emphasized in the program that employes are to deal with facts and not opinions.

Flow chart. Third tool is the flow chart, which shows in a combinational descriptive and graphical manner the flow of work or form between organizational units or between individuals in the same organizational unit. The flow chart is just another means for recording facts. It is left to the individual employe to decide whether a process chart or a flow chart, or both, can be used to advantage by him to record the facts.

Work count. Fourth tool is the work count. By showing what is done and who does it, the work distribution chart shows the division of work through a step-by-step picture of a task or activity. The process or flow chart shows the sequence of work. The work count completes the fact-gathering by showing how much volume of work is being done, and it assists in scheduling the work.

Followup procedure. As in most other programs of this type, a good

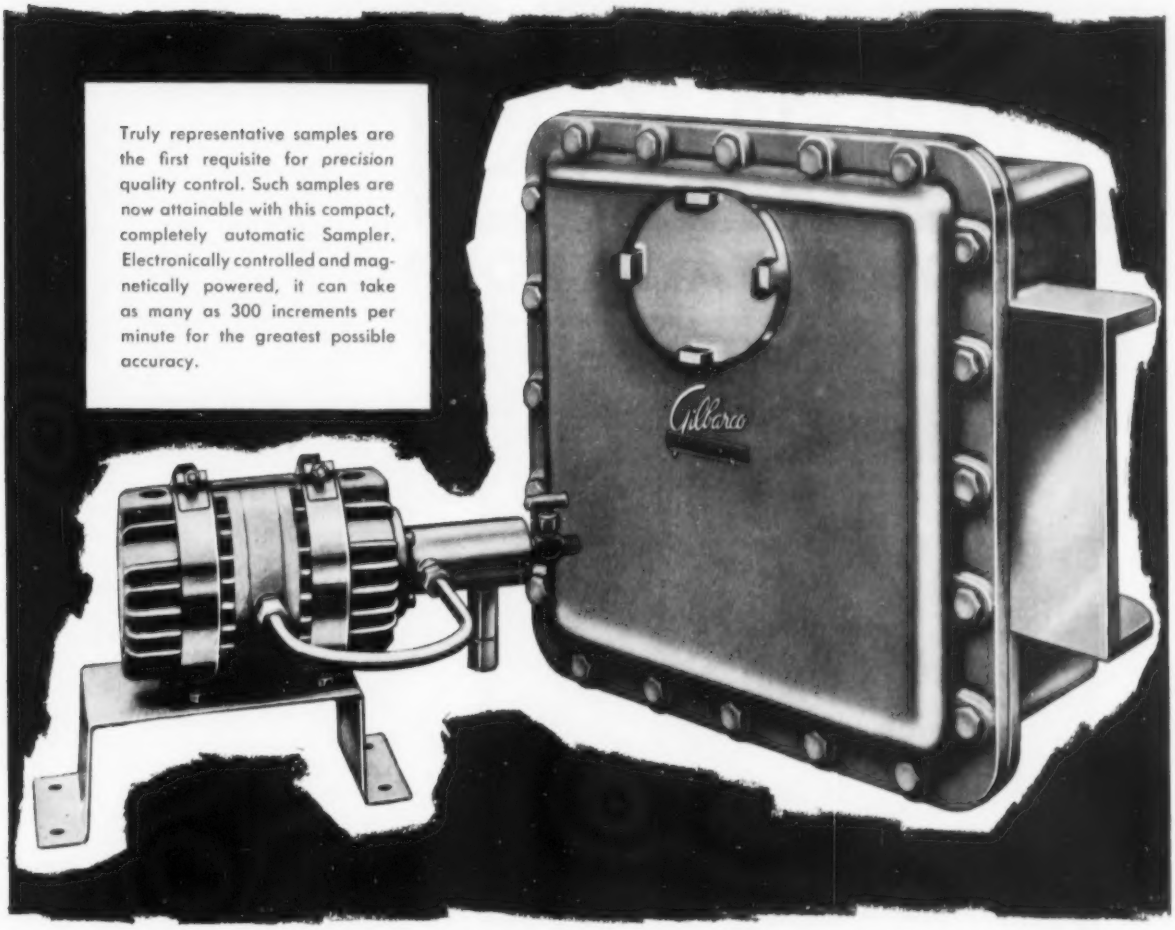
Meet the Author

WILLIAM E. SEXTON has been with Continental Oil Company for more than 30 years. He is a graduate of Southeastern Teachers College in Durant, Okla., and holds a B.S. degree in commerce and marketing from Oklahoma A & M College. Prior to joining Continental in 1924, he did accounting and auditing for Southwestern Bell Telephone Company. Now director of office methods, his experience with Conoco has included positions in the Treasury, General Auditing and Controller's departments. Presently he is manager, office and services. He is author of several articles published on disbursements audits, forms control and office machines and equipment.

PRODUCT PROTECTION

as you've never known it...

with the new **GILBARCO AUTOMATIC SAMPLER**


Truly representative samples are the first requisite for *precision* quality control. Such samples are now attainable with this compact, completely automatic Sampler. Electronically controlled and magnetically powered, it can take as many as 300 increments per minute for the greatest possible accuracy.
Gilbarco

TAKE ADVANTAGE OF THESE IMPORTANT FEATURES

- No packing glands, no leakage
- No electric motor or mechanical switches
- Easy to install and service
- LOW initial cost . . . LOW maintenance cost
- Samples proportional to time or flow
- Explosion proof . . . no pressure relief valves needed
- Frequency range from 20 to 300 cycles per minute
- No hold-up time from pipe line to sample receiver, because a portion of the stream is bypassed through the sampler.

Get full particulars on the New Automatic Sampler before you buy any other unit.

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Gilbert & Barker Mfg. Co.,
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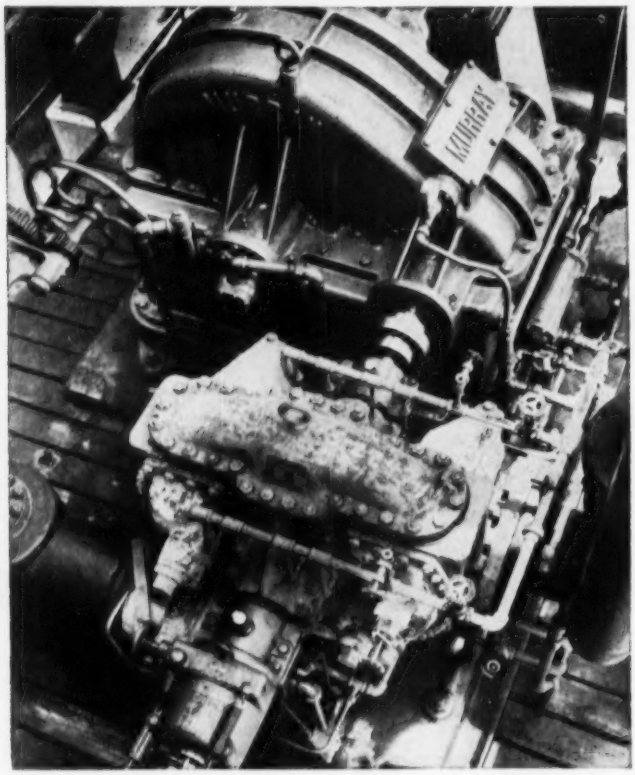
Murray Turbines

OUTDOOR INSTALLATION?



THE RIGHT ANSWER—MURRAY

The turbo-gear unit shown above has been installed outdoors with virtually no weather protection for many years. The turbine exhausts to a process line carrying 170 psig pressure. Yes—for rugged applications—the right answer—MURRAY.

MURRAY IRON WORKS COMPANY

BURLINGTON, IOWA

Builders of Steam Power Equipment for Three Quarters of a Century

followup procedure is essential to secure maximum results.

Supervisors and unit heads are asked to review the work distribution charts for the selection of major projects for future study. Major projects are then scheduled for charting, analysis, and completion at a specified time. Quarterly reports to departmental management are then made on the status of all projects. Workers that are scheduled to take the abbreviated course will then assist in completing these projects.

After major projects are completed, a review will be made to consider work that might be necessary and advisable on minor projects.

Costs of program. In discussing work simplification programs, one question generally arises: "What is the cost of the program?"

Continental has one methods analyst assigned to this training program and related functions. Part of the time of another person is used occasionally. For instance, it is necessary for two individuals to start and to lead the analysis sessions and to assist in the groups of four people.

Card charts, manuals, and other materials reproduced for this program have been handled by company equipment. The only out-of-pocket costs have been for the materials. Including the Wharton School short session and excluding the salary figures, out-of-pocket cost to date has been less than $1500. There has been a small amount of paid overtime which was paid to conferees, resulting from their taking the course and at the same time getting out their normal work load on schedule.

Benefits of program. In addition to cost reduction through time savings and decreased nonproductive work, these benefits are being derived from the program:

1. It provides a basis for rearrangement of organizational units and provides the means by which the spread of individual tasks within the unit organization may be made.

2. It is a good supervisory training tool.

3. It assists in obtaining greater understanding on the part of individuals in the department which leads to the

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LOOKING FOR EXTRA OCTANES?

...they've been found with

AEROCAT® CATALYSTS

A survey of 42 cat crackers showed that those using Aerocat were averaging 2½ octanes higher than comparable units operating with natural catalyst! But extra octanes are only one of the benefits assured by Aerocat. High throughput, low stack loss and excellent stability contribute to the high overall efficiency.

Equally important... behind AEROCAT'S *efficiency stands*

OPEN-EYED RESEARCH... that keeps making innovations in catalyst design... keeps looking for new ways to solve catalyst problems.

HARD-HEADED QUALITY CONTROL... that insists on "specification *plus*" in every carload that leaves the plant.

FIELD-TRAINED TECHNICAL SERVICE... that knows how to relate specialized knowledge of catalyst production to your cracking problems.

CYANAMID

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REFINERY CHEMICALS DEPARTMENT
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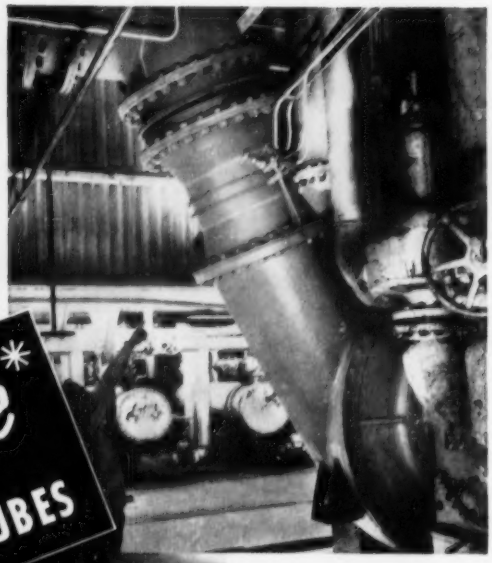
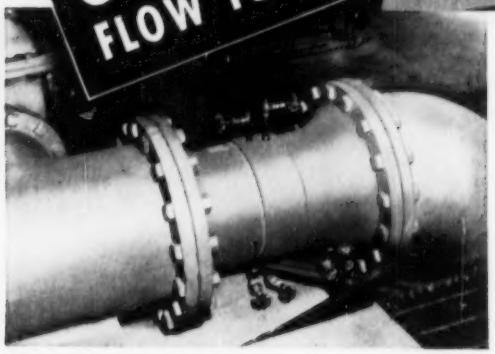
PIPING LAYOUT IS SIMPLER with Gentile* FLOW TUBES





...THEY NEED SO LITTLE ROOM

Gentile Flow Tubes are impact type head meters for use as differential producers.

They are short and they need only minimum straight runs entering and following, and can be installed at practically any accessible point where flow conditions are reasonably steady.

Flow Tubes are furnished with individual head capacity curves, and for unusual piping arrangements, calibration curves for simulated conditions can be furnished.

Guaranteed

- Accuracy
- Minimum Head Loss
- Reproducibility

*GEN-TIL-LY

FOSTER ENGINEERING COMPANY

835 LEHIGH AVENUE UNION, N. J.

AUTOMATIC VALVES • CONTROL VALVES • SAFETY VALVES • FLOW TUBES

As Management Sees It . . .

creation of a spirit of departmental and company cooperation.

4. It provides the basis for better cooperation between the supervisors and others in the same organization units and in other units. It assists in opening the lines of communication both ways and sometimes solves problems that are common to several parts of the organization.

5. It assists in securing more finished and well developed ideas.

6. The process charts obtained from studying the various problems have usage as procedure manuals.

7. Data collected on the work distribution chart and through the work count provide information by which the unit cost for particular functions can be determined.

8. The data collected can be used to advantage in preparation for electronics.

9. It gives valuable information to the Office Methods Division.

10. It gives all employes a better understanding of the functions and activities of the Office Methods Division. With this knowledge, employes know that they may secure assistance on particular problems when and where they need help.

Program plans. To complete the conferences in the Controller's department and to complete the followup procedure will take more than a year. As circumstances change and new equipment comes on the market, new problems are faced. Certainly it will be necessary to review periodically projects which have been studied in detail in the past to find the one best way for doing the job at that time.

In the future, some supplemental sessions covering such subjects as motion analysis, office equipment, office layout and forms design may be considered. It may also be desirable to give instructions in the use of other charts, such as flow diagram charts, left and right-hand charts, and multiple activity charts.

The analyst may be called upon to assist other departments and locations in simplifying their office work. A series of unit head conferences are on occasions arranged for those in regional offices.

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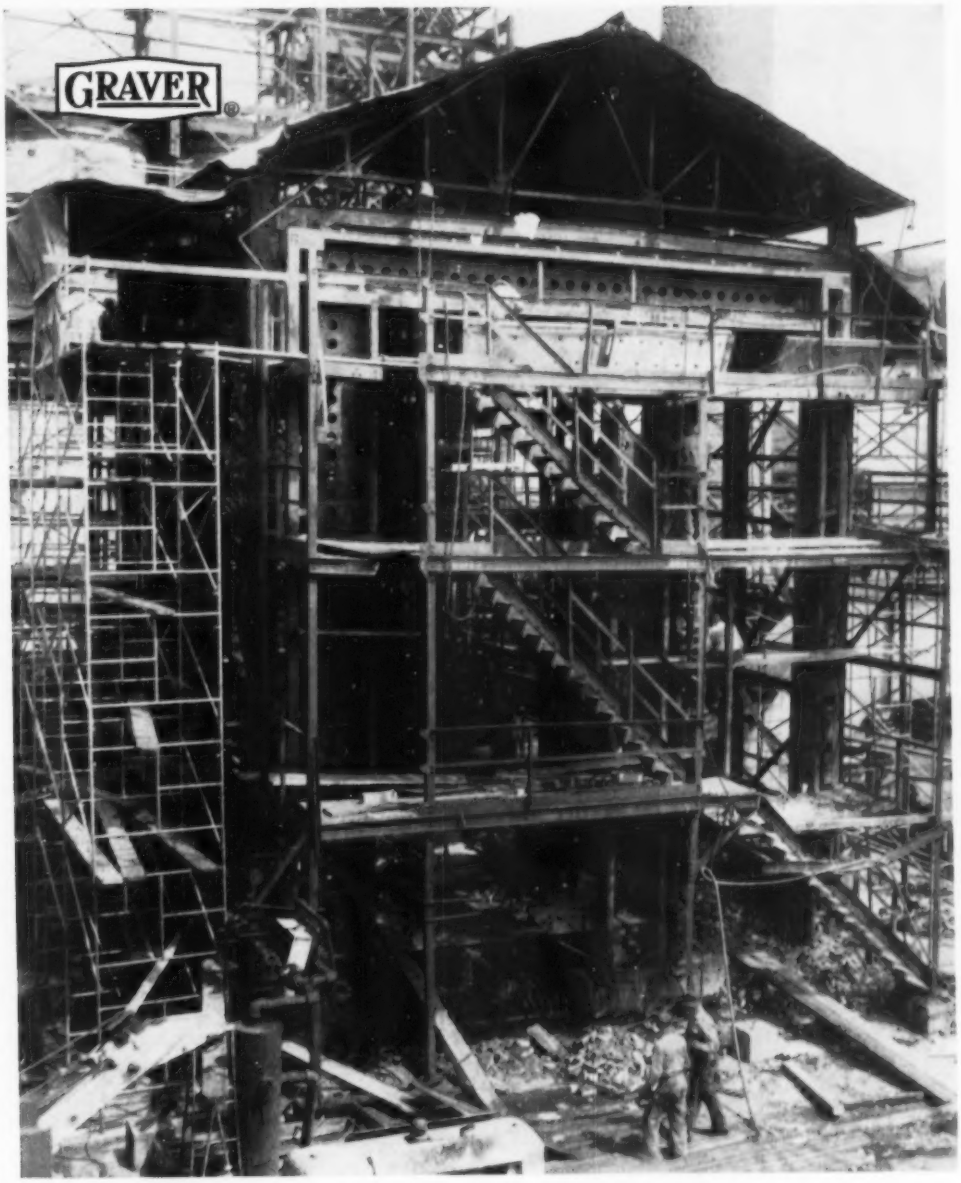

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Chem. processing
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Oil refining ✓
Petrochemistry
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There's order in this confusion

Graver is building a pipe still heater for an oil refinery. It is by no means the first Graver pipe still heater, and Graver builds in like proportion such things as complete refineries, chemical plants and steel mills.

Graver experience has been accumulated over 20 years, and as contractor or subcontractor on your big job, Graver will deliver with the right skills and the right equipment.

Other Graver services include setting machinery, mechanical and piping installation, and plant maintenance.

GRAVER CONSTRUCTION CO., INC.

424 Madison Avenue, New York 17, New York

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Why Suggestion Systems?

Is your company "against" suggestion systems? If it is, then management will benefit from these convincing arguments in their favor . . .

William S. Wilcox
University College, Rutgers
Newton Square, Penn.

OIL MANAGEMENT is widely split in its attitude toward suggestion systems. Companies using these systems have complete faith in their value. The "non-users" are violently opposed to adopting such plans.

It is significant to note that there are less than 25 oil companies using suggestion systems—and they include the most progressive and consistently profitable firms in the industry. On the other hand, the National Association of Suggestion Systems (Chicago) and Suggestion Plans Association (Los Angeles) report more than 1000 industrial members. To say the oil industry is poorly represented is putting it mildly.

Before explaining why so few oil companies use suggestion systems, it is only fair to point out that in many "non-user" companies employe thinking on suggestion systems is completely opposite to that of management. So much that in two recently recorded instances (including one major Midwest company) unions have initiated general surveys of suggestion systems in industry as a foundation for "selling" the idea to management. This is an unusual paradox for oil management—particularly since it is generally recognized as one of the most employe-conscious groups in industry.

While relying heavily on employe relations and benefit programs, oil management rarely applies the hard lessons of competition to its thinking about the employe group. Nor does management realize the need to provide active rewards and positive incentive to individual employes. Why does this situation exist?

A large portion of the oil industry seems to reject the probability that the ideas of its employes can increase efficiency or reduce costs through the facilities of a suggestion system. In the words of an unbiased petroleum researcher: "I've really done some leg work on this among companies without suggestion systems. I find that those who don't have such are adamantly opposed to the point of belligerency, and no amount of selling would convince them otherwise."

One company after a faint hearted trial run abandoned its suggestion system with the public statement to employes that all probable improvements had been made. Other companies, without recourse to a trial, have reasoned out loud that petroleum manufacturing processes 'on stream' offered too few opportunities for rank-and-file ideas, and in their view other operations such as marketing, distribution and producing provided no lucrative source of usable ideas.

Another major firm closed its mind firmly against an employe suggestion system on the basis that the company was entitled to such ideas as the employes had without having to pay for them. This point of view—though logical—is impractical because employes in their own thinking at all levels of a company are competing with other employes. That is the business system by which a company exists and its working out cannot be screened from employes. The goal of every employe is personal recognition and reward.

Pay Increases? When, as in some management thought, recognition and reward is confined to a sometime promotion and pay increase, the fulfillment of either may be improbable, even impossible in a selected case. The most idea minded employe may not be the best material for promotion—and a union negotiated pay scale or a maximum pay limit may not permit merit increases.

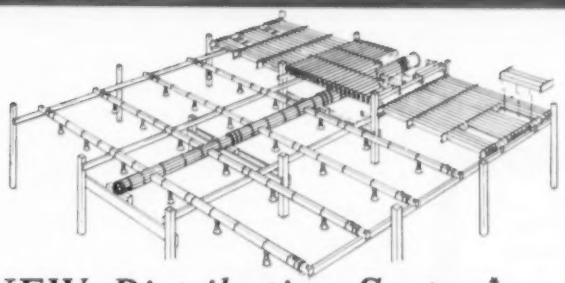
In fact, it seems uneconomic to grant a merit increase for an idea, or even a series of ideas. A pay increase goes on for a working lifetime whereas

SUGGESTION SYSTEMS offer three distinct advantages over the "open door" approach:

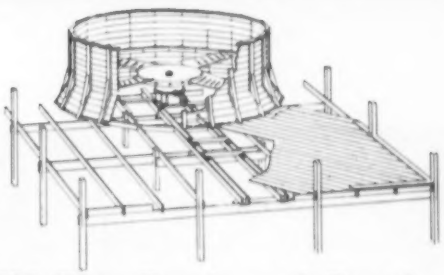
- **They certify that there is an official means for encouraging, handling and deciding on the use of employes' ideas.**
- **They provide a guide for management in selecting and awarding those ideas that are practical and usable.**
- **Results of the use of these means and guides are recorded in terms of performance which can be audited and evaluated.**

The new IMPROVED *Fluor "FPA" Cooling Tower*

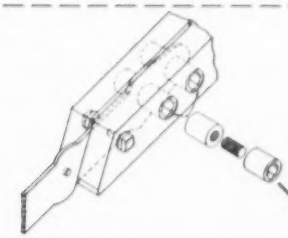
your best DESIGN *buy because . . .*



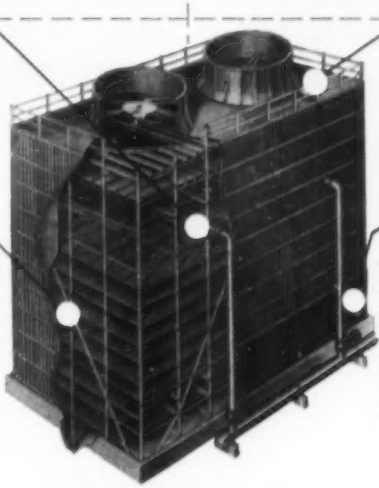
NEW *Distributing System** Completely non-corrosive . . . header and laterals of redwood stave construction banded with stainless steel . . . nozzles of porcelain and stainless steel. All headers and laterals are provided with cleanout valves and plugs for flushing during tower operation.

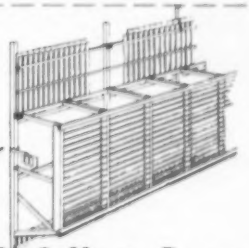


NEW *Fan Deck and Stack* Diagonal decking, blocking and stress strips form a *structural diaphragm* which distributes live loads – wind, vibration – uniformly to *all* bracing. New stack has stress strip around entire periphery.



NEW *Joint Connectors** Unique round-headed socket nuts present a greater bearing surface to the wood than does bolt shank . . . allowable value per connector is increased. This together with the heavier gusset plate design, effectively multiplies each joint's allowable load.





NEW *Offset Louvers . . .* Set three feet out from side, yet require no greater basin dimensions. Air is drawn into tower with less pressure drop. Improvement in winter operation . . . icing problem formerly associated with louvers adjacent to tower columns eliminated.

**Patent applied for.*

The new *improved* Fluor Model "FPA" Induced Draft Cooling Tower is an ideal balance between standardized construction and a tailor-made tower. It reflects Fluor Products' concerted effort – in the face of rising costs – to maintain and *improve* quality for lowest "first" cost. It retains the time-proven design features of previous models of Fluor Induced Draft Counterflow Towers . . . plus *new* design features that deliver maximum service and performance from all components. For optimum cooling capacity per square foot of ground area . . . for a combination of the best in structural design and quality-proven mechanical equipment at the most favorable price . . . and for new design features which ensure year-in, year-out, trouble-free service, look first at Fluor's "FPA" Tower – your *"best design buy"* in cooling towers. Inquiries for details are invited.

MANUFACTURERS AND FABRICATORS OF COOLING TOWERS, PULSATION DAMPENERS, MUFFLERS, PREFABRICATED PIPING AND OTHER WOOD AND METAL PRODUCTS.

FLUOR PRODUCTS COMPANY

A DIVISION OF THE FLUOR CORPORATION, LTD.

GENERAL OFFICES • WHITTIER, CALIFORNIA

SALES OFFICES and REPRESENTATIVES in: *Birmingham, Boston, Buffalo, Chicago, Denver, Detroit, Houston, Los Angeles, Minneapolis, New York, Philadelphia, Pittsburgh, San Francisco, Tulsa.*

ASSOCIATES: *Fluor Corporation of Canada Ltd., Toronto, Calgary; Head-Wrightson Processes, Ltd., London, England.*

a suggestion award based on the immediate value of the idea or ideas compensates the employe and settles the account.

On the other hand, there is a tremendous gain to a company through the facilities of a suggestion system in the daily re-affirmation to individual employe of the importance and vitality of personal initiative, of personal recognition and achievement. These benefits fulfill in a provable way the urge of people to imprint their personalities on work they do.

Help Wanted—A proper aim of a suggestion system is to aid management at all levels in creating within the employe group an awareness of the need, and to provide incentives for employes to reduce costs and increase the efficiency and the output of their operations.

The concurrent goal of a system is to provide individual managers with facilities through which ideas from employes may be stimulated, recorded and evaluated and thereafter acknowledged in such a manner as to constitute an incentive to the suggester and to other employes. The most direct and dependable incentive used is a money award—it cancels the obligation and at the same time it creates the will to try again. It is the business way to operate the business venture of a suggestion system.

There are two more points which have seriously influenced management thought against the initiation of a suggestion system: Who is eligible for an award for what kind of an idea?

Here again, the way is clear and there need be no confusion or complication. The awards of a suggestion system should be available to rank-and-file employes whatever their job title and job responsibilities. This is the whole grass roots reservoir of brains that management needs to draw ideas from.

However, at succeeding levels of a company there are those who have supervision over other employes or who have assigned responsibilities for the initiation of new and improved methods. From all of these, technicians, engineers and researchers awards should be withheld for adopted ideas which have a direct effect on the processes of their assigned work.

To pay awards to these employes for ideas resulting in the increased production or the improvement of their job performance would in effect be paying twice—once by salary for the job and once by suggestion award for performance. It has been amply demonstrated in the operation of many companies that this small minority of potential suggesters rarely use the suggestion system to convey their ideas to management. In one group of 8000 such people, less than two hundred of them had used the formal system in a six year period—of these about 60 percent were found to be eligible for an award. The determination of eligibility hardly exists in actual practice as a serious problem because of the self-regulation exercised by these responsible people.

Is Morale Hurt? Finally, the possible rejection of more suggestions than the number accepted presents to some managements what appears to be a morale destroying problem, and therefore it is used as an argument against initiating a suggestion system. In practice the ratio of acceptances may range up to a near 100 percent in any given location. It depends on the employes' iniative and

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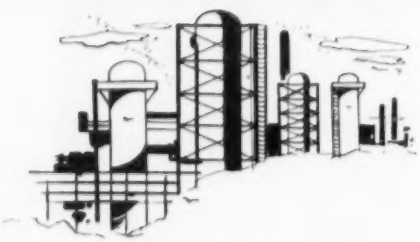

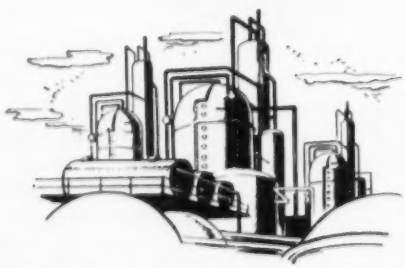

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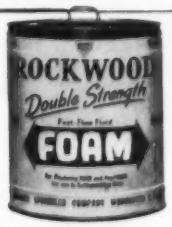

* **Rockwood Double Strength FOAM.** Puts out fires in flammable liquids, and in ordinary combustibles, quicker, at lower cost. Three parts FOAM and 97 parts water create a tremendous heat-resistant blanket. Flows freely at —15°F.

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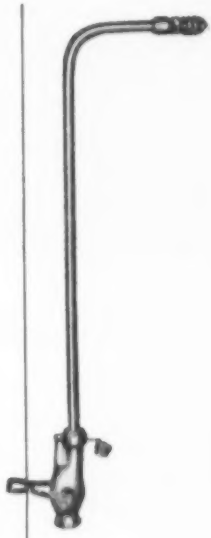

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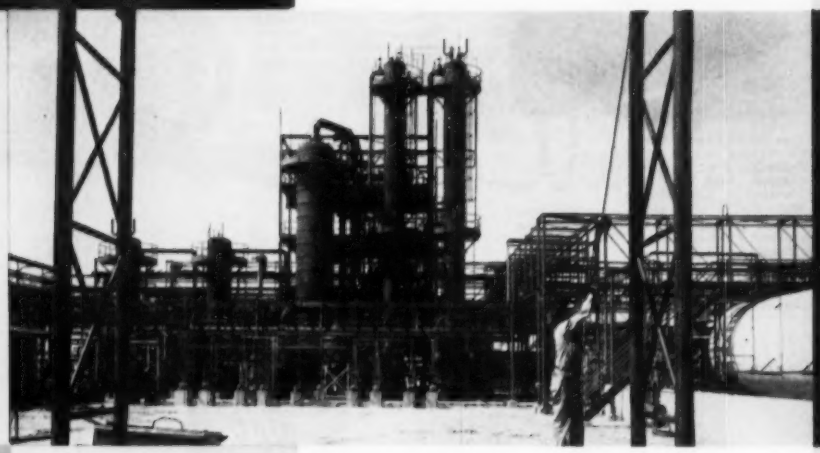

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alertness, the intelligence of the promotion of the system and the care taken to analyze the problem posed by the idea itself. The records established by many major industrial companies throughout the country, including some of the oil industry, over a number of years clearly proves that a morale factor of rejection does not adversely affect a well run system.

One of the well run systems—The General Motors Corporation—recently reported to the public that last year it had received a record 192,030 suggestions from its employes of which 24 percent (i.e. 46,995) were adopted. Inasmuch as they paid out $2,467,513 in awards, the return to General Motors must have been substantial. The 75 percent rejection ratio does not react against the continued use of their suggestion system because year after year, they establish new high records for American industry.

Another company, a major unit in the oil industry, reports that in 1955, 40 percent of the individual suggesters received awards averaging $29 each—19 percent received two or more awards—75 percent of the individual suggesters were repeaters from previous years—and 25 percent were newcomers to the system.

A suggestion system should never be considered as an employes benefit nor should it be charged off as a labor burden. P. C. Salman, Comptroller of the Socony Mobil Oil Company, Inc., stated in a public address last year: "If the suggestion system is to compare favorably with other uses of corporate funds, it must reflect an adequate return, after covering all expenses—it takes a considerable amount of money to establish and maintain a suggestion system until it can be said that 'accumulated suggestion savings' have provided the working capital requirements of the system."

After an analysis of the Socony Mobil company's suggestion system, Salman concluded: "I look upon this suggestion system as an operation which has paid out promptly and has provided an adequate return on investment—although I recognize that payout and return on investment analysis are only tools used in aiding management's judgment, it does seem that most managements would be interested in an investment which can pay out in five years and earn 800 percent over 20 years." In substance, employes' ideas have cut costs and returned a profit.

The Payoff—Notwithstanding, many companies in the oil industry have so far failed to profit through the potential for increased efficiency and reduced costs that exists in the brains of rank-and-file employes. The industry has depended in great degree upon the static incentives of job assurance and fringe benefits and the even less tangible satisfactions as a way of influencing employes to propose ideas for improvements. There is no proof that employes are responding to these static incentives in any substantial manner.

For the industry to ensure to itself all the potential benefits inherent in employes' ideas, an active and a more impelling incentive is necessary—the suggestion system is a facility readily available to companies in the industry. It can and should be operated as a business venture subject to auditing as to its costs and as to its return to a company, and it should be expected to return a profit. ##

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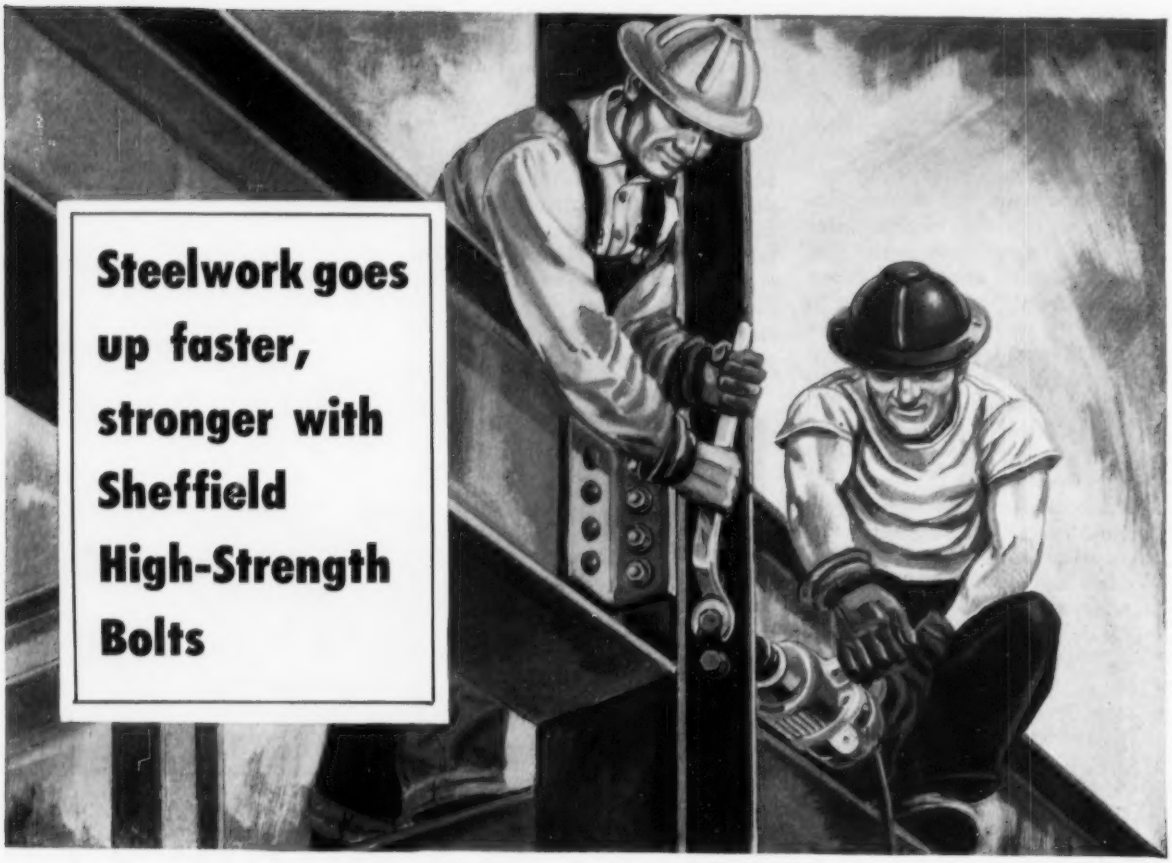

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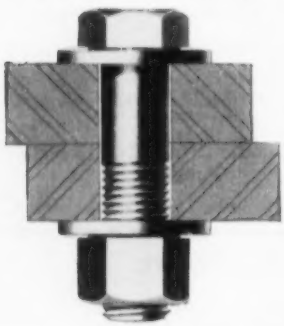

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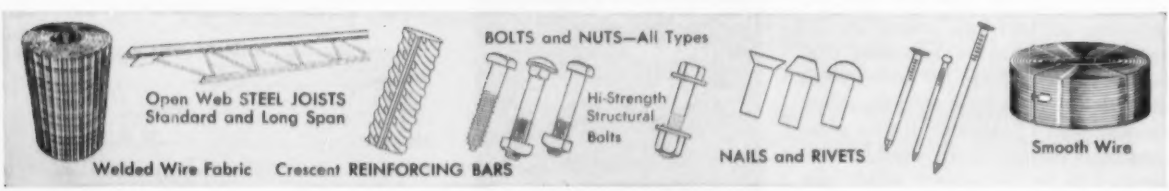

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AN EXCLUSIVE REPORT:

Refining Inside the Iron Curtain

Despite stepped-up refining activity, Russia and the European satellite nations are lagging far behind the U. S.

PETROLEUM REFINER Staff

RUSSIA IS EXERTING every effort to increase its refining capacity. But, these efforts are falling far short of U. S. totals—and will continue to for many "five-year plans" to come.

The fifth Soviet five-year plan (1951-55) demanded a 100 percent increase in Russian refinery capacity. At the end of this period there were 70 refineries in operation, with a total crude charging capacity of 1,247,000 barrels a day. Of that total, 637,000 barrels a day were processed by cracking plants.

The sixth Soviet five-year plan (1956-60) demands acceleration of the tempo while the cost of constructing new oil refineries must be reduced to a minimum. Refinery capacity is to be increased nearly 900,000 barrels a day through the building of new plants. Cracking capacity is to be increased by not less than 500,000 barrels a day.

The plans mentioned above are for Russia alone. Ambitious undertakings are also in store for the satellites. Latest in the Soviet's fast-changing line of oil ministers, M. A. Yevseyenko, recently announced the following objectives for the 1956-60 plan (including Russia and satellite nations):

"In the years of the new five-year plan, it is necessary to provide for an increase of 60 million tons (1,150,000 barrels a day) in oil refining capacity. This is the equivalent of putting into operation every year two new plants of 6-million-ton (115,000 barrels a day) each.

"If it be considered that construction of one plant takes five to six years, then it becomes obvious that old methods of designing and constructing oil refineries are quite inadequate for achieving the goals set in the new five-year plan."

The total refining capacity of the Soviet and satellite nations currently is estimtaed at 1.5 million barrels a day—the sixth five-year plan expects to increase that total to 2.7 million barrels a day, of which about half would be cracking capacity. Even by 1960, Russia's crude charging capacity will be less than one-third the 8.4 million barrels a day U. S. refineries totaled at the end of 1955. That is, if the new plan reaches its goal.

The Leaders Speak. In propagandizing Russia's stepped-up refinery activity during 1955, Soviet Oil Minister (at that time) Mikhail A. Evesejenko stated:

"The refining capacity of heavy raw materials with the aid of catalytic cracking installations is widely used at all oil processing works. Due to improved technology and the use of better apparatus, the separation of oil products and raw materials has been improved at many works and installations, and the output of refined products has been increased.

"Refineries successfully master the output of new products. The enterprises of the Grozny oil works have produced an experimental consignment of natural fat substitute for soap making. The Kuibychev oil processing works has begun producing an excellent insulating material for the cable industry."

Speaking about the 1956-60 five-year plan, Minister Evesejenko said: "One of the most important tasks in the oil industry is the automatism of the workings and of refineries. Satisfying the national economy's growing requirements for petroleum depends to a considerable extent on the further raising of labor productivity at oil-processing enterprises. It is necessary to improve the use of oil equipment, to reduce the idle period of installations during current and capital overhaul."

Premier Bulganin declared in July, 1955, that "new catalytic cracking and reforming plants must be built and the output of 'light products' be increased. The quality of fuels is to be increased, too."

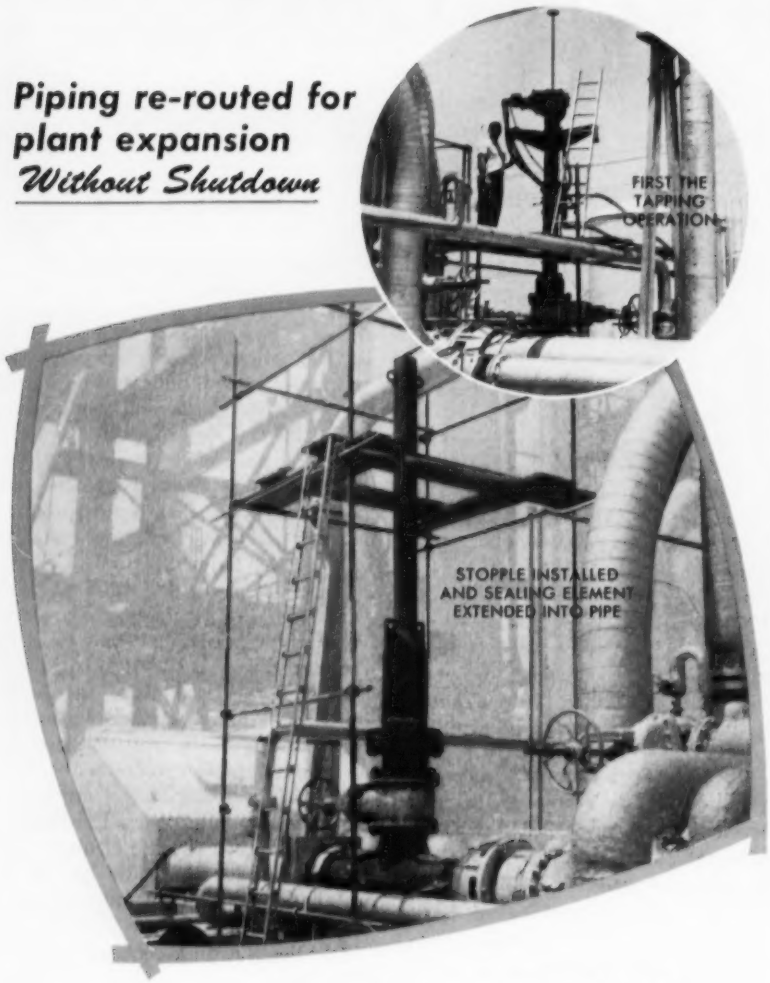
Russian leaders also voiced complaints about the oil industry last year. Output of "white products" in

The U. S. has 3 times as many refineries with 5½ times more crude charging capacity than Russia and the European satellite nations combined:

Country	No. of Refineries	Crude Charging Capacity (Barrels a Day)
Russia	70	1,247,000
Rumania	14	67,100
Poland	6	78,300
Czechoslovakia	6	63,000
Hungary	5	53,700
Yugoslavia	3	16,300
Bulgaria	1	6,700
East Germany	1	1,900
Albania	1 (to be completed)	2,900
Total:	107	1,536,800
U. S. Total:	300+	8,400,000 (Dec., '55)

ANOTHER PLANT AVOIDS SHUTDOWN

Piping re-routed for plant expansion Without Shutdown



Piping changes are made while flow continues through temporary by-pass around section sealed off by a pair of STOPPLES

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As Management Sees It . . .

the "Second Baku" area was lagging behind the 1951-55 plan, despite a 64 percent increase in white product yield from crude during 1954, compared with a 57 percent increase in 1951.

Using U. S. Equipment. New plants were mentioned during 1955 in Bensina, Potapovo near Oktjabrsk and Dshershinsk (Oka). Two refineries are operating in the Arctic area of the U.S.S.R. Built near the Taimyr Peninsula oil field (started in 1938), the refineries use U. S. equipment.

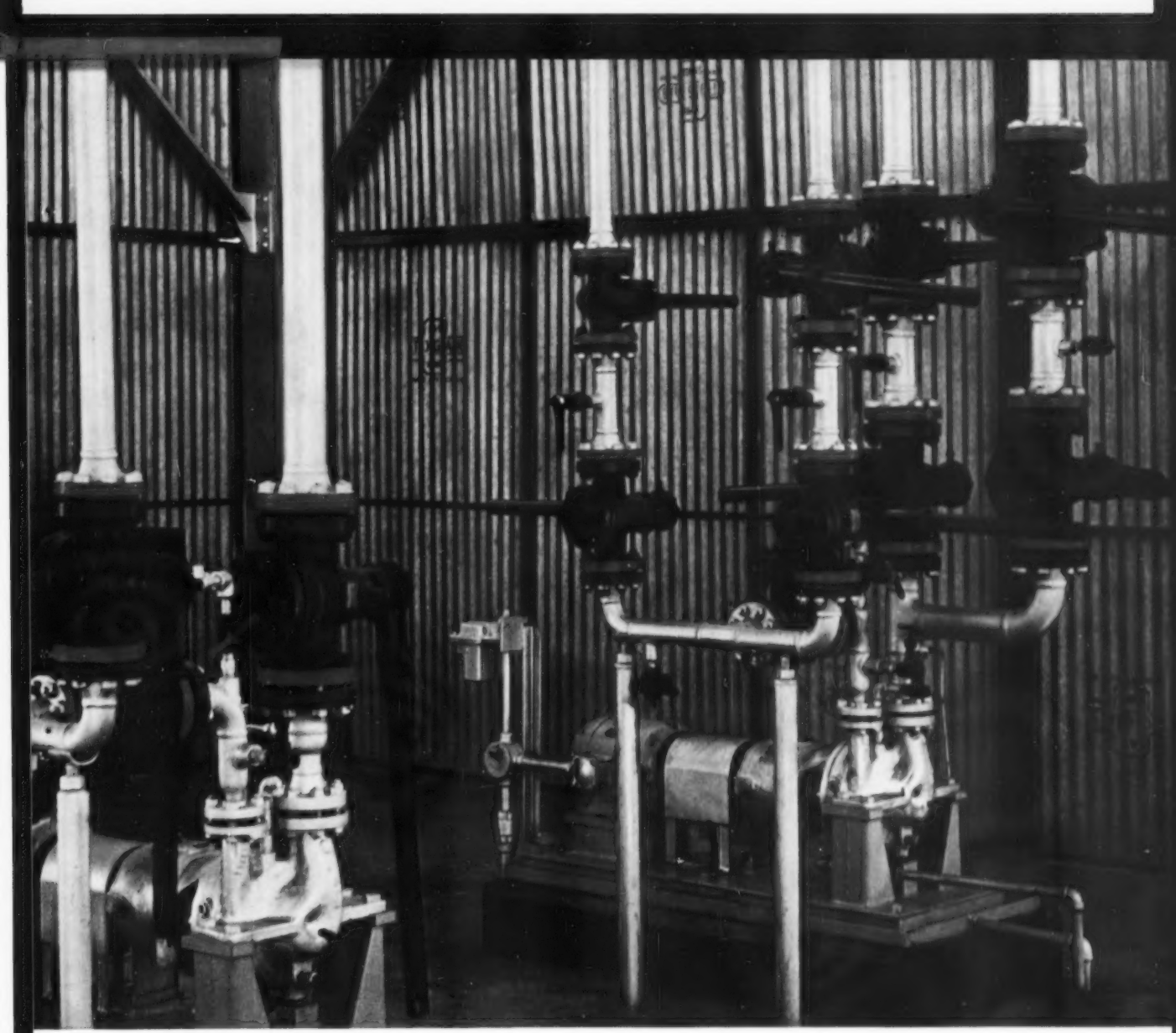
Capacity is sufficient to fulfill the requirements of aviation bases in the Soviet Arctic area. In the Baikal Lake district, one refinery exists near Utulik where crude from the Murino and Sneshnaja fields is processed for local consumption.

Mention was made of a refinery near Stalingrad during August, 1954. The refinery exploded (according to West German statements), killing L. B. Safrasijan, deputy oil minister, and A. N. Vavulin, technical chief of the Ministry's refinery construction department. Pravda also reported the "sudden death of the deputy minister and the chief engineer" in its August 15, 1954 issue.

The Azerbaijan Oil Refineries Association announced the refineries' pledges for 1956 last April. The Gyurgyan Oil Administration has undertaken to produce 1000 barrels of light oil a day above the government plan and 190 barrels of oil a day, to lower production losses by 400 barrels a day (as compared to the norm), and to lower the specific norms of fuel expenditure by 100 barrels a day, electricity by 1 million kwh and acid by 7266 tons.

They pledge labor productivity increases of 1.5 percent, and to save 8 million rubles ($2 million) through the introduction of proposals of rationalizers and innovators to train or raise qualifications of 1200 employes. Planned for 1956 is the beginning of new oil additive production. Also planned is the introduction of the processing of heavy oil residues at the Vano Sturua refinery.

The sixth five-year plan demands that the following work be done in the refinery sector. The Russian Soviet Republic received the order to



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When you use Rockwell-Nordstrom valves you get "extras" you can't buy in ordinary valves. Pressurized lubrication in the Sealdport* system assures leakproof sealing (without uncertain "forced" seating), and eliminates costly wearing friction. Because they are rotary plug valves, quarter-turn operation and unexposed seating are two more money saving extras. The cost? Rockwell-Nordstrom valves cost no more to buy (often less) than ordinary valves and cost much less to use.

Forty years of lubricated plug valve leadership by the original and world's largest manufacturer is your assurance of economy and trouble-free dependability when you specify Rockwell-Nordstrom valves. Rockwell Manufacturing Company, Pittsburgh 8, Pennsylvania.

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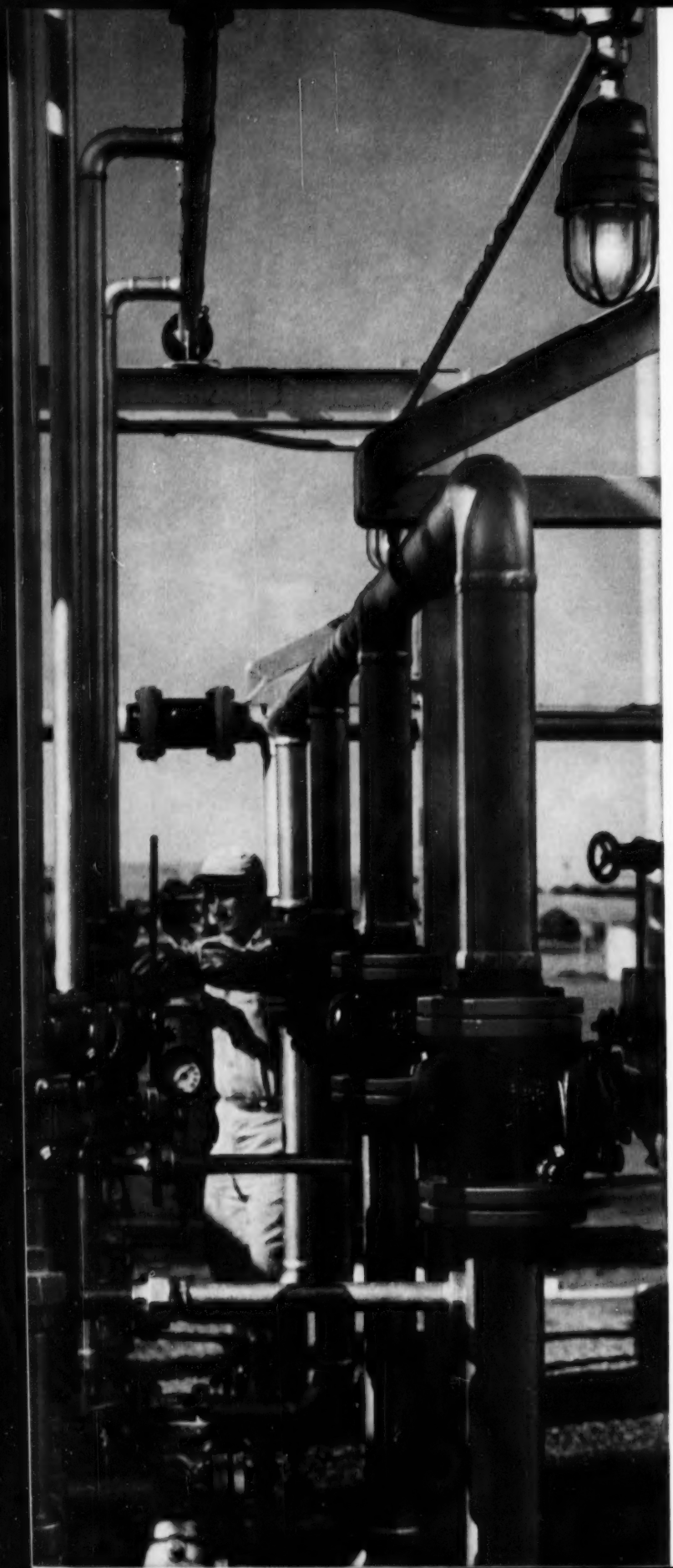

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You can use Rockwell-Nordstrom valves in complex manifolds where ordinary valves wouldn't even begin to fit. Because they have no heavy, bulky bonnet cavities or rising parts, Rockwell-Nordstrom valves take little more space than their flange diameters. Additional advantages: positive shut-off prevents product contamination; firmly seated plug and rugged construction prevent shock load failures that are common to ordinary valves on pulsating flow.

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Lubricant Sealed for Positive Shut-off

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of lubricated plug valve leadership

"finish the Omsk refinery and to build new refineries at Krasnoyarsk Territory and in the Amur region."

In the Ukranian S.S.R. "construction of one refinery is to commence during the next five years." The Bjelorussian S.S.R. was informed that "construction work on two refineries is to commence."

The Uzbeck S.S.R. will see "one refinery taken into operation during the next five years." Finally, the Estonian S.S.R. is to "locally refine shale oil found near Jarvae. The Akhtma shale-gas plant is to be built."

Synthetic Fuel. In the synthetic fuel industry, annual capacity is estimated to be between 40 and 60 thousand barrels a day. Part of the East German-Leuna-Merseburg brown coal synthetic plant has been installed in the Dshershinsk (near Gorkij) plant. Aviation gasoline and nitrogen are produced there.

During 1953 a project was announced at the Baikal Lake. Commercially obtained East German equipment for a 20,000 barrels a day synthetic plant was under consideration, but nothing has been heard since that time.

The U.S.S.R. is reported to have had a total of 52 smaller coal-utilizing synthetic fuel plants in operation, most of them serving local communities and industries. The Soviets signed an agreement with the Chinese Peoples' Republic on March 7, 1956, concerning Soviet delivery of a complete synthetic fuel plant to Red China. ##

Stockholders Set New High

THE NUMBER of U. S. stockholders is multiplying at a phenomenal rate. At the beginning of 1956, 8.6 million American owned stock in at least one publicly owned company, 15 percent more than those who held shares at the end of 1954 and 33 percent more than in 1952.

A recently conducted shareholder census produced an estimate of 1.4 million persons who own stock in closely held corporations only. This would bring the total U. S. stockhold-

TRIPLE ADVANTAGES EFFECTED BY *National-U.S.* EVAPORATIVE CASCADE COOLERS...

at the sulphuric acid plant of The Eagle-Picher Company Galena, Kansas

A unique installation of National-U.S. large evaporative cascade type coolers is solving the cooling problem for The Eagle-Picher Company in the manufacture of sulfuric acid at Galena, Kansas.

Each cooling unit combines the water cooling principles of a conventional wood tower with the heat exchanger principle of National-U.S. cast iron cooling sections through which the acid flows.

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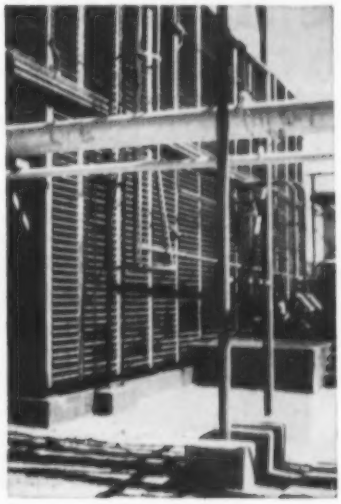
2. **SAVES SPACE—takes up little more room than a conventional raw water cooling system.**
3. **SAVES IN FIRST COST—because of reduced space and by eliminating a separate cooling tower.**

The entire cooling area is blanketed with spray from a series of jet nozzles forming a checkerboard umbrella of water over the coolers and pit. Water circulation quantity is two-and-a-half times that of a conventional installation. A proportionate cooling effect is exerted on the heated water from the heat transfer surface, plus considerable evaporative effect from warm water on the surface of the sections.

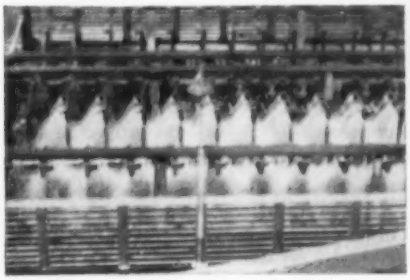
Over two years of operating experience has proved the efficiency and the triple advantages of this installation of coolers designed by National-U.S. engineers.

For full information, get in touch with National-U.S. Heat Transfer Division, whose engineers will also be glad to discuss your particular cooling problems with you.

Exterior view of the coolers at Galena, Kansas sulfuric acid plant of The Eagle-Picher Company. Note the resemblance to a conventional cooling tower. Circulating water pumps can be seen at the left.



Looking down on water sprays in operation at the evaporative cooler. (Installation was made by Leonard Construction Co., Chicago.)



HEAT TRANSFER DIVISION

National-U.S. Radiator

CORPORATION

HEAT TRANSFER DIVISION HEADQUARTERS
342 Madison Avenue, New York 17, New York

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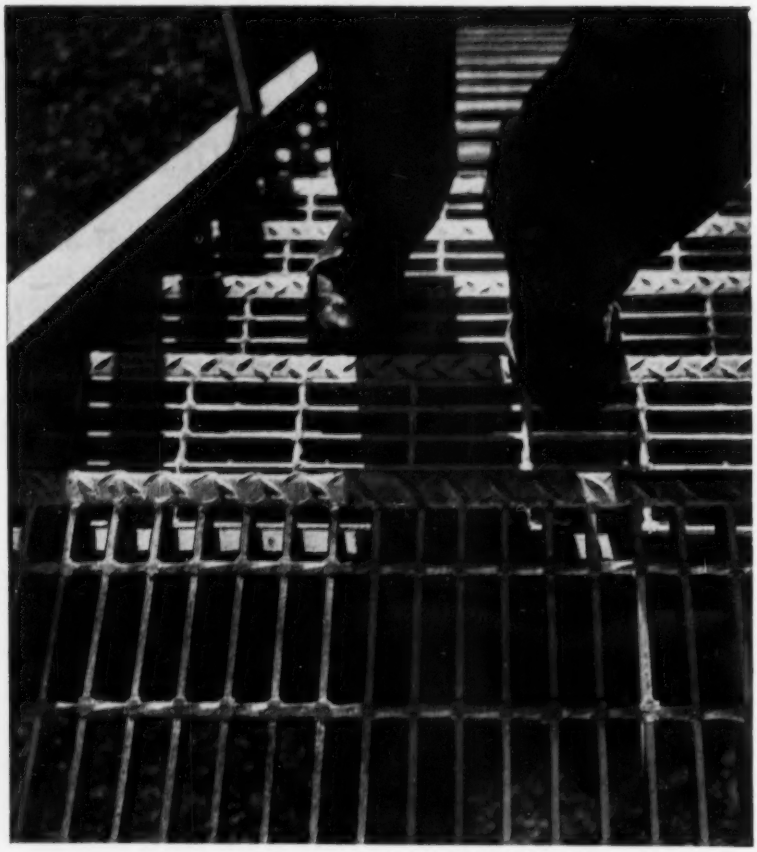
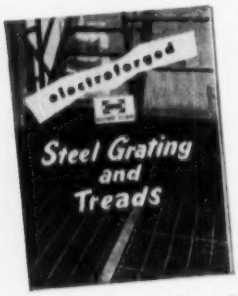


... make every step a safe step

BLAW-KNOX ELECTROFORGED® STEEL GRATING and STAIR TREADS

On stair treads, walkways, catwalks, platforms and floors—both indoors and outdoors—you can provide safe walking conditions. For Blaw-Knox Electroforged Steel Grating brings you these exclusive features:



1. rigid one-piece construction—easy to install
2. non-slip twisted crossbar—for safe footing
3. three types of bearing bars
   - square bars—for smoothest walking surface
   - knurled bars (Furro-Grip)—for extra safety plus relatively smooth walking surface
   - serrated bars—for maximum safety under extremely hazardous skid conditions
4. no sharp corners to clog—self-cleaning
5. all surfaces accessible—easy to paint
6. maximum open area—for light and ventilation

Write for your copy of new Bulletin No. 2486 —or send dimensional sketch for quotation.

50th Anniversary BLAW-KNOX 1906-1956

BLAW-KNOX COMPANY

BLAW-KNOX EQUIPMENT DIVISION

Pittsburgh 38, Pennsylvania

GRATING APPLICATIONS: floors • platforms • walkways • catwalks • stair treads • fan guards • shelving • and many other uses, both outdoors and indoors, for versatile steel grating

As Management Sees It . . .

ers to 10 million. And over 100 million people are "indirect investors" through their stake in life insurance, pension funds, mutual savings banks or other stock-owning institutions.

Four years ago the typical shareholder earned $7100, but today the average is $6200—even though national income has risen sharply in the meantime. Nearly two-thirds of the current shareholders live in households earning under $7500, one-third earn less than $5000. However, the proportion of shareowners goes up sharply as income increases: From 2.8 percent stockholders among families earning less than $3000 to 28.6 percent in the $7500 and up category.

The incidence of stock ownership also rises with increased education. Three out of ten college graduates own stock. So do one in ten high school graduates. But, among those who never reach high school, the rate is only 1 in 59.

The median age of stockholders has been cut from 51 in 1952 to 48 in 1956. This is still five years older than the median age for the U. S. adult population. Pollsters estimate that half of the 2 million-plus new shareowners added since 1952 are under 35.

Key factors encouraging younger investors are the improved economic status of the younger age group—and the spread of employe stock plans.

##

Eye Injury Is a Major Industry Hazard

In the United States alone more than 80,000 persons have lost the sight of one eye as a result of industrial hazards—and nearly 8,000 have lost the sight of both eyes.

The importance of industrial vision is not only fully understood, states Dr. H. W. Hofstetter in his forthcoming book, "Industrial Vision." And the fact that am employe's eyes are tools as specialized in the application as the hammers, gauges and files he uses to carry on his trade has often been disputed by experts.

"The confusion," Dr. Hofstetter says, "seems to lie in the attempt to associate vision characteristics with specific jobs or typical job classifications, rather than with the vision requirements or the visual demand specifications of the job." ##

Model way to ship bulk liquids

EVERY DAY the "liquid assets" of companies throughout America travel safely and surely in S.H.P.X. tank cars. Present capacity is more than 100 million gallons—and still rising!

There's good reason for this growing dependence upon Shippers' Car Line. As lessor and exclusive sales agent for ACF-built DURADOMES, we offer industry the finest tank cars that roll. They are designed for easier cleaning, maximum insulating efficiency and the best possible application of lining.

As transportation specialists, Shippers' maintains a network of offices and repair shops at strategic locations from coast-to-coast to keep rolling stock on the move... and to assure customers of prompt, dependable service.

Whether you prefer to buy or lease, you can be sure that Shippers' is prepared to meet your *special* requirements every time.

SHIPPERS' CAR LINE

DIVISION OF ACF INDUSTRIES, INCORPORATED

30 Church Street, New York 7, N. Y.

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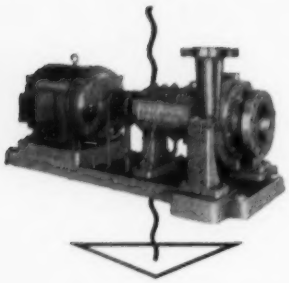

How "heads up" engineering keeps your pump costs down

It takes a lot of pump savvy, a lot of "heads up" engineering, and a big investment to design and build a line of pumps that can withstand the wear and tear of today's continuous process pumping—*and still be in line, price-wise.*

Dean Brothers did it with their fully engineered line of standard centrifugal pumps. And they have built into these pumps a ruggedness and reliability usually found only in costly, individually engineered pumps. They did it by making practically every component part interchangeable between all pumps in the same series—something never before attempted over such a wide range of application.*

For example, the eleven pumps in Series 10 can handle 90% of all process pumping jobs. Every one of these pumps is built of the same parts except for the Casing, Impeller, and Suction Nozzle—which vary with the capacity of each pump. And for temperatures up to 350° F. the cradle housing is built without water jackets. *All other parts are the same.* With a single cradle assembly for eleven different size pumps, you get a lot of pump for your money—in soundness of design, in strength, in durability.

If you'd like to know more about the many "long life" features of all Dean Brothers standard centrifugal pumps, send for Circular No. 184A.

**Series 10, Series 20 and Series 30—to 7,000 gallons per minute capacity.*

HERE'S JUST ONE EXAMPLE

Repacking is costly and time consuming. But because one shaft fits all eleven pumps, Dean Brothers was able to make that shaft extra big and engineer it with an extra short overhang. So shaft deflection is kept to a minimum even under heaviest loads. Result: much less wear on the packing. Protection of the packing against the ravages of heat, in high temperature service, is assured by a *water jacket which completely encircles the entire length of the stuffing box.*

And when a mechanical seal is used, it fits into the same stuffing box—a neat bit of cost-saving standardization.

DEAN BROTHERS PUMPS INC.

INDIANAPOLIS 7, INDIANA

Centrifugal and Reciprocating Pumps · Since 1869

As Management Sees It . . .

Phillips Construction

Continued from page 196

with 1949 expansion of the Cactus ammonia plant, Phillips dismantled and moved to Cactus a government-owned nitric-acid plant and built an ammonium-nitrate and nitrogen-solution plant. Later these plants were expanded to a daily capacity of 355 tons of nitric acid, 389 tons of ammonium nitrate and 150 tons of nitrogen solutions.

Triple Superphosphate—Phillips built a triple-superphosphate plant at Adams Terminal in 1953. The addition enabled the company to supply phosphate in a concentrated form and provided another way to upgrade sulfur.

Plastics and Chemicals

In 1955, Phillips Chemical started construction of a plant at Adams Terminal to manufacture 110 million pounds a year of polymers. It also started construction of an ethylene plant with a designed capacity of 290-million pounds per year adjacent to the Sweeny refinery to supply ethylene for the polyethlene facilities.

At Adams Terminal in 1952, Phillips started production of methylvinylpyridine from a plant with an annual capacity of 2 million pounds for use in synthetic fibers. Capacity of this plant has since been raised to 3 million pounds a year.

NATURAL GASOLINE

Gasoline Plants—In natural gas liquids, Phillips net output in 1946 was 1,664,000 gallons a day. In the ten years since, this phase of the company's operations have been expanded giving it a daily output in 1955 equal to about 2,840,000 gallons.

Construction of five new plants since the war has given the company 25 wholly owned plants in Texas, Oklahoma and New Mexico, with a total gas-processing capacity of 2600 Mmcf. a day. In addition, it has a part interest in four plants which it operates with a daily capacity of 330 Mmcf. Eleven plants, partly owned by Phillips but operated by others, have a daily capacity of 675 Mmcf. Also the company has under construction a wholly-owned plant with a capacity of 80 Mmcf. a day.

Fractionation of Natural Gasoline—The central fractionation facilities at Borger, Texas, have been ex-

panded in a number of steps to raise the natural gas liquids feed capacity from 2,000,000 gallons a day in 1946 to the world record volume of 4,600,000 gallons a day in 1956.

Besides the segregation of components for aviation gasoline blending, many special fractions are produced for solvent and chemical plant use. Phillips separates some 20 hydrocarbons from natural gas liquids.

Phillips' first production of cyclohexane was in 1946. In 1950 additional equipment was installed for full scale production of cyclohexane as a chemical feed stock. Current production rate is more than three times as great as the rate in 1950.

In 1946 the production of primary reference fuels of normal heptane and isooctane began at Phillips' Rice Plant. Now, nearly all of the country's production of these materials comes from that plant.

Normal Butane Treating—Since 1946 facilities for treating of normal butane for removal of hydrogen sulfide and mercaptans have been expanded such that their capacity now exceeds one million gallons per day. The product is doctor sweet and noncorrosive.

Mercaptan Production—The commercial production of 98 percent ethyl mercaptans was begun in 1955 and presently amounts to about 130,000 pounds per year. This material is recovered from the butane treater waste gas stream.

Reforming and Other Conversion Processes—Several different processes for cracking light hydrocarbons have been installed and produce ethylene as feed stock for the only existing diisopropyl alkylation plant.

The supply of naturally occurring isobutane is augmented by the production of over 200,000 gallons a day of isobutane from a butane isomerization unit. This material is used in the diisopropyl plants as well as the Borger H. F. alkylation unit.

A 7000-barrel-per-day catalytic reforming unit was constructed in 1954. The unit processes a heavy ends of natural and refinery straight run feed to produce reformate for avgas. Current feed is in excess of 8000 bpd.

Other processes are being installed including a unit designed to upgrade feed stock for avgas and motor fuel.

##

the NEW USG SUPERGAUGE®

...built to last a lifetime!

With proper application, the new USG Supergauge will last a lifetime!

SEGMENT—stainless steel, with nylon-faced gear section. Nylon-to-metal bond stabilizes the nylon against expansion and contraction . . . maintains accurate pitch diameter . . . assures proper mesh with stainless steel pinion under severe temperature and moisture conditions.

MONO-UNIT CONSTRUCTION—permits easy removal of complete gauge assembly for inspection and adjustment.

ARC-LOC MOVEMENT—permits all calibration adjustments of gauge assembly from rear without removing dial and pointer.

LEGEND ON DIAL—gives complete description of socket, Bourdon tube and movement material for ready identification.

MICROMETER ADJUSTABLE SELF-LOCKING POINTER—permits accurate repositioning of pointer.

These features are also available in USG Solfrunt Gauges with solid front construction.

Supergauges available in 4½", 6", and 8½" sizes. For complete information on case styles, materials of construction and connections write for Publication 1819.

UNITED STATES GAUGE
Division of American Machine and Metals, Inc.
Sellersville, Pa.
USG
Home of the SUPERGAUGE

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Sharp Rise in World Oil Demand Within Next Five Years

To satisfy probable increase will require industry to invest heavily, among other things, in plants and equipment.

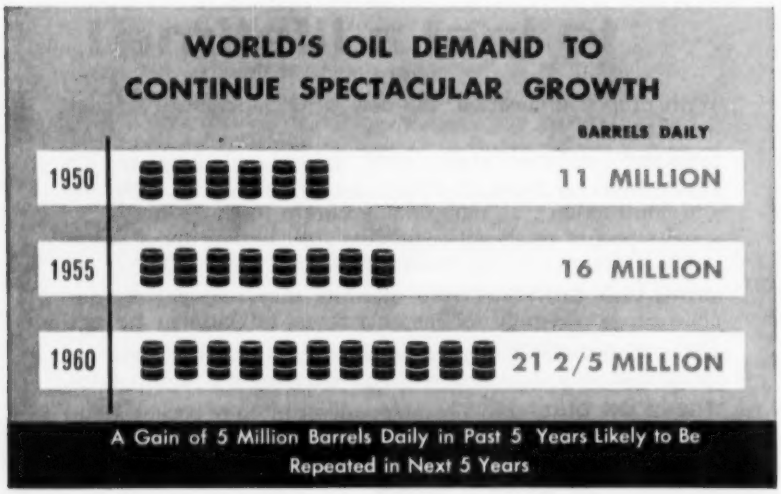
WORLD REFINING capacity will have to be increased substantially if 1960's demand needs are to be filled.

World total consumption of petroleum products is likely to reach nearly 21½ million barrels per day by 1960. This would be one-third greater, or almost 5½ million barrels daily above the 1955 record volume, double the 1950 rate, and three times larger than in 1946 when world consumption amounted to only 7¾ million barrels per day.

Oil consumption needs to grow at only slightly larger than recent growth rates to attain such a volume by 1960. The almost 5½ million barrel increase anticipated for the period between 1955 and 1960 compares with a 5-million-barrel rise during the last five years.

Number of automobiles, trucks, buses, airplanes, tractors and motorcycles is expanding at a faster pace than ever before. Industrial capacity is increasing at the sharpest rate in history, and more oil is being used for heating of homes and plants. Growth in all these phases is especially rapid outside the U. S. These trends are expected to continue in the years ahead. They promise vastly enlarged oil consuming rates.

To provide sufficiently enlarged supply to satisfy such a large increase in oil demand will require that the industry continue to invest heavily in new wells, plants and equipment. Production, transportation and refining capacities all will need to be expanded. Despite present surplus propanded.


WORLD'S OIL DEMAND TO CONTINUE SPECTACULAR GROWTH
BARRELS DAILY
1950
11 MILLION
1955
16 MILLION
1960
21 2/5 MILLION
A Gain of 5 Million Barrels Daily in Past 5 Years Likely to Be Repeated in Next 5 Years

Forecast of World Demand for Petroleum Products
(Barrels Daily)

	Forecast 1960	1955	1950	1946
United States	**10,325,000**	**8,415,000**	**6,507,000**	**4,912,000**
Outside U. S.	**11,150,000**	**7,653,000**	**4,468,600**	**2,865,900**
North America Outside U. S.	1,225,000	860,900	524,000	440,000
Caribbean Area	400,000	310,400	225,800	153,600
Other South American	925,000	696,500	469,200	223,600
Europe excluding U. S. S. R.	4,100,000	2,670,800	1,440,000	808,300
U. S. S. R.	2,000,000	1,368,000	770,000	514,700
Middle East	450,000	349,500	250,000	145,000
Far East and Oceania	1,475,000	971,000	513,500	420,700
Africa	575,000	425,900	276,100	160,000
World Total	**21,475,000**	**16,068,000**	**10,975,600**	**7,777,900**

Biggest growth outside of U. S. Demand for oil has been growing at a faster pace outside the U. S. during recent years. In line with this trend, a larger rate of growth will be shown outside the U. S. during coming years. By 1960 the rest of the world is expected to be consuming more oil than the U. S., although the latter accounted for nearly two-thirds of the oil used by the world in 1946.

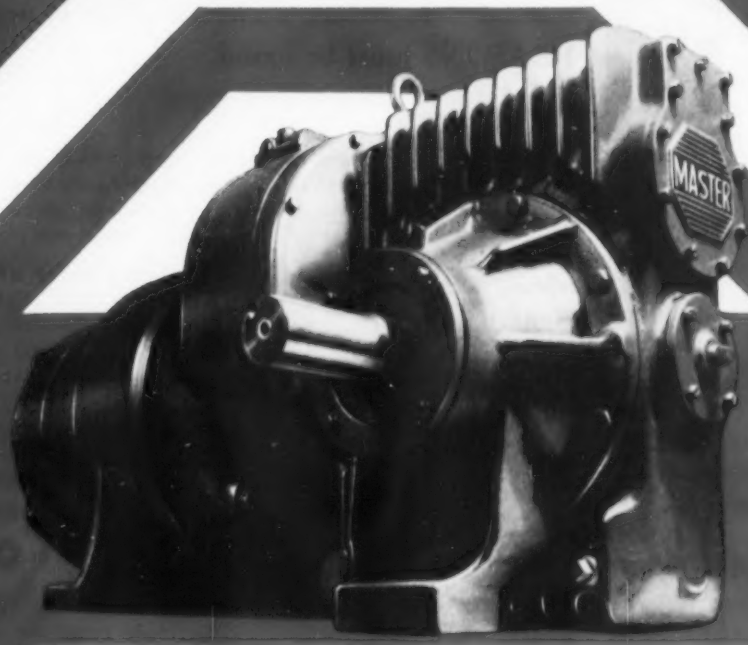
Demand outside the U. S. is seen as exceeding 11 million barrels per day by 1960. At that time, the U. S. is expected to be using 10 1/3 million barrels per day.

The consumption forecast for 1960 calls for an increase outside of the U. S. of 3½ million barrels or one-half more than the 1955 volume.

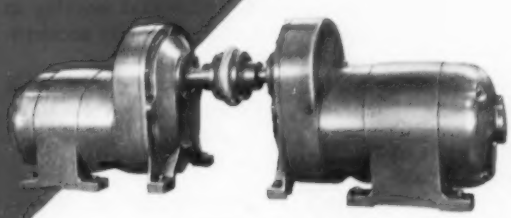
MASTER

still the All-American First

Master Gearmotors have given more millions of hours of satisfactory service in the field than all other makes combined.



CONTINUOUS LIFE TESTING
MAINTAINS
CUSTOMER SATISFACTION



How can *we* help YOU?

For five years without stopping, these two 326 frame single reduction gearmotors were run continuously 24 hours a day at full load, one as an induction generator, the other as a gearmotor. When shut down and inspected, Master's conservative design showed *gear wear of less* than .001".

THE MASTER ELECTRIC COMPANY • Dayton 1, Ohio

Strahman

HIGH PRESSURE GAUGES

USED IN
REFINERIES
AND
CHEMICAL PLANTS
THROUGHOUT THE WORLD

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REFLEX
Single or Multiple Sections

TUBULAR

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Large Chamber Reflex Gauges
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COMPLETE CATALOGUE

STRAHMAN VALVES, Inc.
16 Hudson St., New York 13, U.S.A.

Accidents can be prevented if you . . .

Find the REASONS For Unsafe Acts

Too many refineries expect a set of safety standards to reduce accidents. This is not enough. The REASONS must be found.

"THE TROUBLE with most safety programs is that plant executives seldom take the trouble to get to the *cause* of unsafe acts in their factories and remove them," a safety engineer reported recently. "Instead, they set up a series of standards and expect them to do the job. By themselves, standards will seldom attain the desired results."

His remarks point up the basic necessity of finding each and every reason for unsafe acts in the refinery before formulating a program to eliminate them. Without an understanding of these conditions it always is difficult to set up safety procedures that will be genuinely effective. Merely copying ones that proved useful in another refinery never attains that 100 percent goal.

The problem of finding the reason for unsafe acts in a refinery begins with a study of mechanical conditions which may exist. Even the most safety conscious workman will have accidents if he must work under unsafe conditions. The study is strictly a routine affair conducted by someone able to recognize these situations where they exist.

Even with this solution the problem is far from solved. The reasons that permit unsafe acts as they apply to the men and women who work in the refinery also must be located. Finding these conditions mentioned in the paragraph above probably accounts for 10 percent of the solution, while finding the others embraces an area of 90 percent and are therefore worthy of considerable study.

A number of studies have been examined. They embraced every size and type of plant operation. Here is a short list of the more important factors which the refinery executive should have under consideration while examining specific reasons for unsafe acts in his own plant.

Improper attitudes—This includes wilful disregard, recklessness, laziness, disloyalty, a lack of co-operation and many other personal approaches on the part of employes which lie directly at the cause of accidents. They all are attitudes of mind which must be understood before an effective safety program can be designed. Failure to understand means that the whole program can "go over the head" of such individuals on the staff.

Such improper attitudes also include oversensitiveness, jealousy, impatience, absent mindedness, phobias, plain inconsideration and intolerance. Whenever the cause of a given accident is looked into, a search for any one of these conditions will help lead to a better understanding of the cause and a remedy applicable not only to the staff as a whole but to each individual.

Personnel adjustments are required as part of the safety program in handling any such conditions. Sometimes better placement of the individual on the job can remove the accident potential where he is working today. Many firms have found that a highly accident-prone individual working at a given job becomes entirely accident-free when placed on another.

In rare cases rigid discipline is necessary to handle such a situation. Sometimes medical or psychological approaches are needed.

Lack of knowledge or skill—Another very important factor among reasons for unsafe acts in any refinery

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ASK THE EXPERTS... about ORBIT VALVE performance and quality

Valves get a fast, unbiased appraisal by the experts — men who buy and use them. The best recommendation Orbit could ask for is the fact that these experts regularly specify Orbit Forged Steel ASA Class Valves. They are used for many processes and applications in petrochemical and petroleum hydrocarbon plants. The performance of Orbit valves proves the importance of buying valves engineered, designed and built for specific uses.

Full Round Opening sizes available in Flanged & Screw End ASA Class, 1, 1½, 2, 2½, 3 & 4 inches, beginning with 300 lb., thru 2500 lb., Carbon & Stainless Trim.

Venturi Type — available sizes: Flanged End only, ASA Class, 2, 2½, 3, 4 & 6 inches, beginning with 150 lb., thru 2500 lbs., Carbon & Stainless Trim.

ORBIT VALVE COMPANY
P. O. BOX 699 • TULSA 1, OKLAHOMA

ORBIT VALVES ®

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MORE OF THE GARLOCK **2,000**

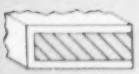
Teflon*-Jacketed Gaskets for Chemical Resistance *Plus* Resiliency

Here is the ideal gasket for joining glass piping, glass-lined steel piping and light metal flanges on processing equipment. Teflon-jacketed gaskets with fillers give you resiliency and deformability impossible to obtain with solid Teflon gaskets. Fillers are available of practically any gasketing material for use in each of the four basic designs indicated at the right.

Teflon-jacketed Gaskets are only a part of the Garlock products available in Teflon . . . and only a fraction of the famous "Garlock 2,000", two thousand different styles of packings, gaskets, and seals to meet all your needs. It's the only complete line. It's one reason you get unbiased recommendations from your Garlock representative.

4 Basic Designs

1 Slit-center. Teflon is slit from outside diameter to within 1/16" to 1/8" of the inside diameter. Any type filler can be used.



2 Milled-center. Machined from outside diameter. Provides flat surface flush with pipe I.D. reduces impedance to flow.

3 Formed Shield. For large or irregular openings such as elliptical manholes.

4 Double Jacket. Two jackets overlapping to protect both O.D. and I.D. Filler of compressed asbestos between layers of soft woven asbestos commonly used.

Write for new Catalog AD-154 which describes Garlock Teflon Gaskets and Sheets.

THE GARLOCK PACKING COMPANY, Palmyra, New York

For Prompt Service, contact one of our 30 sales offices and warehouses throughout the U. S. and Canada.

*DuPont's Trade Mark for its tetrafluoroethylene resin

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints

As Management Sees It . . .

in many cases exists simply because employes have not been sufficiently informed about their jobs and accident hazards involved. When safety education in the refinery is spotty this always exists. It also is prevalent when the firm seeks to accomplish the safety purpose with a generalized program that fails to reach the individual and his specific job problems. The remedies in such cases are obvious.

Misunderstandings also can cause accidents. In those refineries where safety education places final responsibility on the foreman or superintendent he always should make certain that each safety regulation is understood accurately and thoroughly by the individual employe.

Failure to convince the individual employe of the need for caution also has been found to be a contributing cause.

In each of the conditions under this particular point, the remedy lies in instruction and re-instruction. Employes forget; they must be continuously reminded.

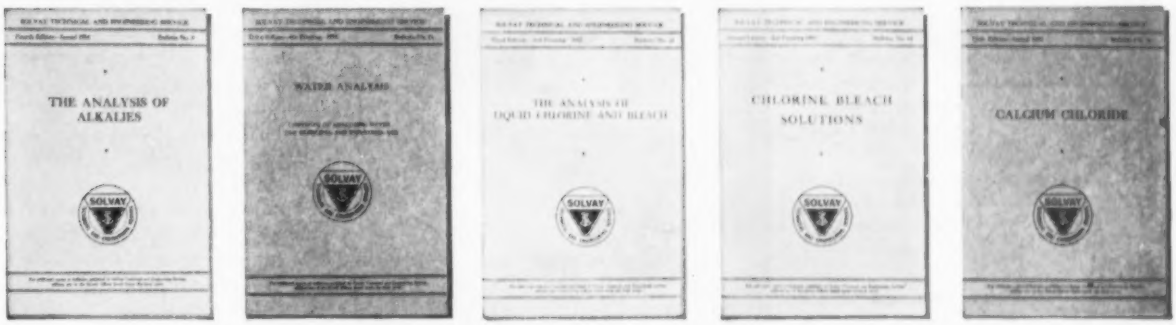
A number of surveys has shown lack of knowledge or skill to be an important cause of unsafe acts in plants where safety is a once-a-year procedure and then is forgotten the rest of the time.

Safety education should be a continuing process in any refinery. Those which make it continuous are always the ones with lowest accident figures. This continuing responsibility rests not only with the individual foreman but with the executive department of the firm for pressure upon the former must always come from the latter.

Physically unsuited individuals—There are few refineries in the country today in which such a hazard does not exist. It should be eliminated completely. The employe so handicapped never has a real chance to be a safe individual at his job. Periodic medical examinations are being used in many large plants as an approach to locating such individuals. The employe physically safe at the beginning of his employment offers no guarantee that he will continue to be safe for years ahead; time has a way of decreasing the physical efficiency of all.

Any check up on this factor should examine such conditions as hearing,

THESE SOLVAY TECHNICAL BULLETINS



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WHAT'S THE PRICE OF THIS AGITATOR?

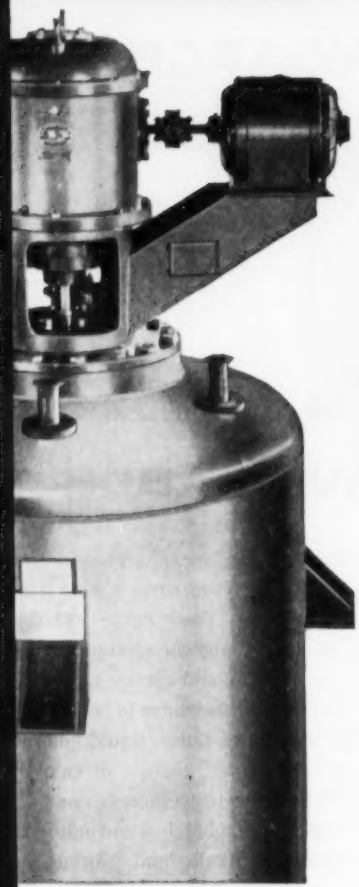
There are three "price tags" that add extra value to the purchase price of a Nettco Agitator. These are:

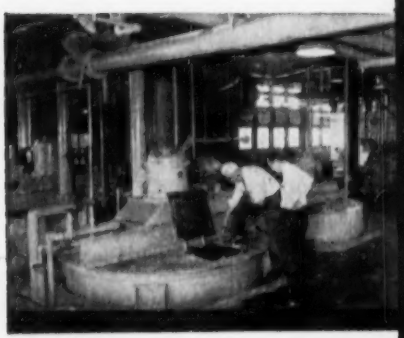
The engineering "price tag" — your assurance the Nettco drive is the right size, the right speed, the right horsepower, the right shaft diameter — backed by Nettco's over 50 years of serving the agitation needs of Industry.

The operating "price tag" — your assurance the Nettco unit is engineered for low power consumption and high productivity — two vital economy factors in any processing system.

The maintenance "price tag" — your assurance the Nettco drive will minimize maintenance: with a minimum of moving parts — all conservatively rated.

Next time use Nettco — for engineered agitation that's lowest cost in the long run. Send for data and recommendations, to New England Tank & Tower Company, 81 Tileston Street, Everett 49, Massachusetts





Installation of Nettco Agitators in new multi-million dollar dyestuffs plant — **complete plant served by Nettco Engineered Agitation.**

HELPFUL NETTCO CATALOGS

General Catalog No. 551
Side Drive Agitators, Bulletin No. 532
Nettco Flomix ®, Bulletin No. 531

NETTCO
ENGINEERED AGITATION

As Management Sees It . . .

sight, age, sex, height, acquired minor illness, acquired allergies, slowing down of reactions, physical disabilities that have been acquired, intoxication, increasing nervous tension of the individual and such conditions which contribute to the lack of physical well being in the individual employe.

Improper mechanical or physical environments—This is an additional factor which should be examined in any study of reasons for unsafe acts in a refinery. Environment also can change with time. Buildings and equipment age and deteriorate just as individuals.

A thorough examination of the space factor, for example, is desirable. It is most often overlooked. For some reason this is a condition which seldom is taken into consideration in remodeling, re-design or installation of new equipment and accessoreis to units in the refinery plant. An entirely safe working condition can be quickly changed to an unsafe one by crowding the space in which the employe has to do his job.

Light and heat changes also can create conditions which will lead to unsafe acts on the part of employes. Check-ups should include a thorough examination of these conditions whenever and wherever an accident occurs in the refinery.

Materials, tools, equipment, procedures, company policy, etc., all can be contributors to this cause of unsafe acts. Each should be considered at the time of every accident investigation.

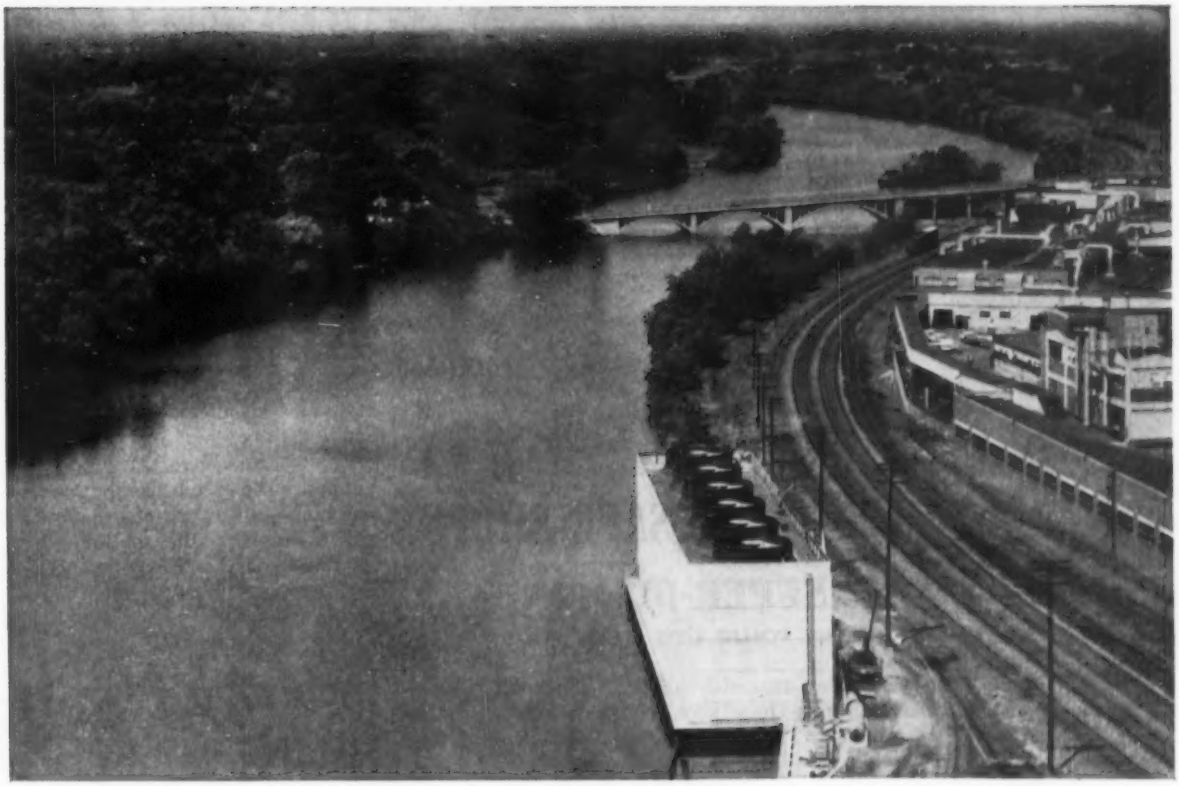
The reasons why should never be neglected in studying any accident. Without uncovering these, work in preventing the recurrance of accidents is blind.

The need for thorough investigation into these, and investigation often of a personal nature, is emphasized in the following examples which were uncovered in a number of studies. They show that causes of unsafe acts can lie in very personal, individual and specific areas which may be ignored when only general thinking is applied.

1. Failure to wear safety glasses—"They are too uncomfortable" was the explanation given by the employe after considerable questioning.

2. Accident caused by men running

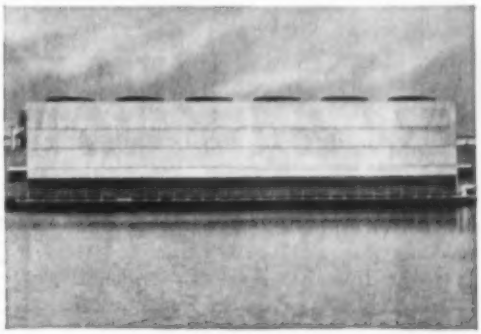
COOLING TOWER
Cooling a River? . . . Yes!



THE Board of Water and Electric Light Commissioners, Lansing, Michigan required 32,000 GPM additional circulating water capacity in order to add a new steam electric generating unit at the Moores Park Station. River flow during the summer months was insufficient, however, to meet the requirements of this rapidly growing load. A cooling tower installation proved the economic solution, in preference to relocating the new generating facilities. *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

Pleasing architectural appearance of the tower was also an important consideration because of a municipal park across the river.

A Foster Wheeler six cell induced draft tower with cement asbestos board casing and stainless steel trim was chosen for this unusual installation.



FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

Spikes reduce slipping on ball diamonds,

but ordinary shoes are SAFE SHOES

on low cost A.W. SUPER-DIAMOND

ECONOMY ROLLED STEEL FLOOR PLATE

Ordinary flat-soled shoes—material-handling equipment, too—move safely over SUPER-DIAMOND's traction treads—from any angle of approach. The raised diamond pattern—40 steel diamonds to the step—has been exclusively designed and engineered for maximum foot safety at minimum cost.

No other floor plate can match A.W. SUPER-DIAMOND *for safety, durability and easy maintenance at so low a cost.*

Write for detailed information.

- **No matching problems**
- **Fast installation**
- **Easily fabricated**
- **Cleans, drains rapidly**
- **Takes years of abuse**

A.W. SUPER-DIAMOND

ROLLED STEEL FLOOR PLATE

"The diamond in the rough . . . a gem of a flooring."

ALAN WOOD STEEL COMPANY

Conshohocken, Pa.

Please send A.W. SUPER-DIAMOND Booklet SD-8

Name_____

Title_____

Company_____

Address_____

City_____ Zone_____ State_____

Other products: A.W. ALGRIP Abrasive Rolled Steel Floor Plate—Plates—Sheets—Strip—(Alloy and Special Grades)

For plants where oil, water and grease raise special problems of slipping accidents, we suggest a check on the special qualities of A.W. ALGRIP . . . the world's only abrasive rolled steel flooring.

As Management Sees It . . .

down stairways—If they didn't hurry in this manner they missed a close connection with a street car or bus and had to wait a long time for another.

3. Accident caused by removal of machine guards—"I took them off because I was always uncomfortable working around the machine . . . they gave me more leg room when I took them off."

4. Accident caused by horseplay—"We were just having fun and never thought it would result in somebody getting hurt."

5. Accident caused by standing too close to machinery—"I hated to admit that my eyes were getting bad and didn't want to get glasses."

Those are just four examples. A study of accident reports will lead to hundreds of others individual and specific to each case. They serve to emphasize the extreme importance of searching out all such contributors to unsafe acts. When they are found better safety rules and regulations can be formulated to avoid their repetition in the future. ##

Industry Profits Hit New High

Major U. S. oil companies earned 15 percent more last year than in 1954—invested 6.4 percent more—paid 26.6 percent more in income taxes and 12.7 percent more in dividends.

In its latest analysis of the financial aspects of the oil industry, Chase Manhatten Bank reports on 34 of the nation's top oil companies. Together, these companies produced 61 percent and refined 85 percent of total U. S. crude oil supplies.

Reflecting the further expansion of operations during the year, gross income of the 34 companies, at $24.9 billion (including $534 million from sales of natural gas) was 2.6 billion or 9.5 percent higher in 1955 than in the preceding year. Tax charges, including income taxes, rose by nearly 20 percent to $1.7 billion, in addition to which $3.1 billion was collected by the companies as taxes on gasoline, etc., for the U. S. and other governments. ##

Stauffer...

major source of

CHLORINATED HYDROCARBONS

PERCHLORETHYLENE?

Stauffer's 'Perk' is available in the Technical grade for industrial degreasing . . . and in the Drycleaning grade . . . both grades stabilized for use in all standard synthetic units.

METHYLENE CHLORIDE?

Lowest in density, boiling point, freezing point and toxicity of all the chlorinated hydrocarbons, Stauffer's Methylene Chloride is available at highest levels of purity for every technical and industrial use.

CARBON TET?

Stauffer is a major source of this widely used solvent, carrier, flame inhibitor, fire extinguisher, and chemical intermediate.

CHLOROFORM?

Stauffer's present substantial facilities will be greatly enlarged in 1957 by the addition of a new plant for the manufacture of Chloroform at Louisville.

STAUFFER CHEMICAL COMPANY

380 Madison Avenue, New York 17, N. Y.
Telephone: OXford 7-0600

Stauffer CHEMICALS SINCE 1885

Stauffer means service

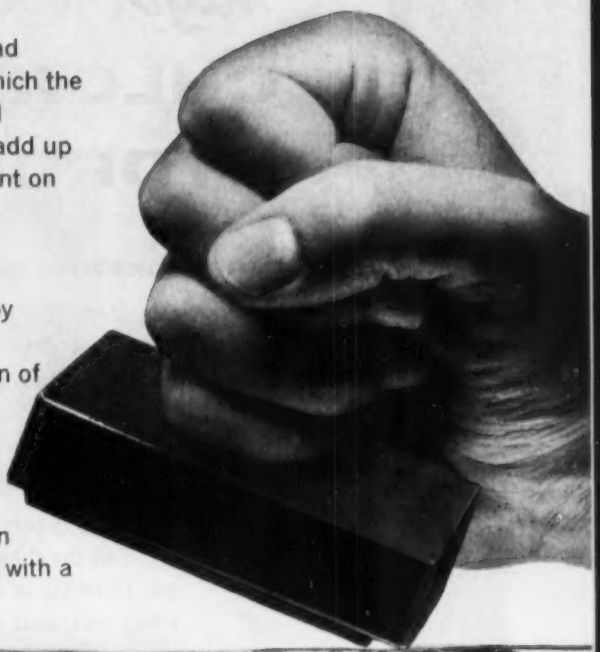
For more data on advertised products, use Readers' Service Cards, last page.

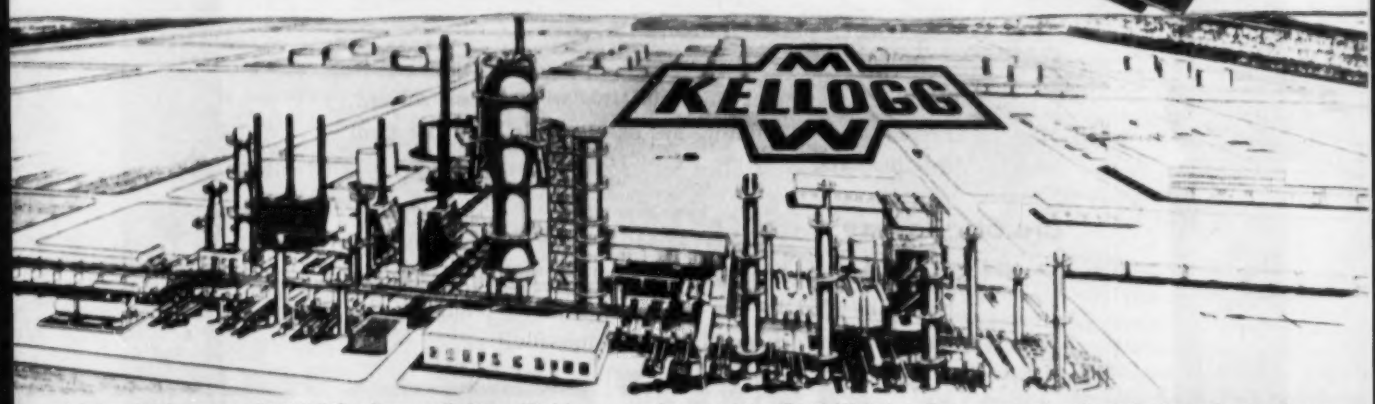
Soundest Way to Erect and Protect a Multi-Million Dollar Investment

The ultimate cost of a 10-, 20-, or 30-million dollar petroleum refinery is determined not by the figure on the engineering and construction contract, but by the speed and efficiency with which the refinery can be put on stream. Lost production can cost an oil company thousands of dollars daily and, for large refineries, add up to millions. Sound protection against delays in putting the plant on stream or against failure to fulfill production guarantees promptly is to assign all or a major share of engineering and construction to The M. W. Kellogg Company.

The bigger the investment, the more a refiner can benefit by enlisting the long and broad experience of this world-wide organization. A contract with M. W. Kellogg expedites selection of the most economic processes . . . integrates plant design for maximum output of individual units . . . assures the proper materials to minimize corrosion . . . means the utmost in efficiency of piping, instrumentation, every phase of the job.

Whatever the assignment or its size, refiners can depend on M. W. Kellogg to get their investment on stream quickly—and with a firm guarantee of product yield and utility efficiency.





American Oil Company's 35,000 BPD refinery at Yorktown, Virginia — now under construction. The M. W. Kellogg Company was given the engineering and construction responsibility for all offsite facilities and a number of the major process units for this $30 million refinery. These units include those for atmospheric distillation, vacuum distillation, fluid catalytic cracking, catalytic polymerization, gas recovery, and gasoline and kerosene treating — all piped together to form one integrated processing operation.

REFINERY PROCESS DIVISION

THE M. W. KELLOGG COMPANY

711 THIRD AVENUE, NEW YORK 17, N. Y.

A SUBSIDIARY OF PULLMAN INCORPORATED

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Companhia Kellogg Brasileira, Rio de Janeiro • Compania Kellogg de Venezuela, Caracas
Kellogg Pan American Corporation, New York • Societe Kellogg, Paris

M KELLOGG W

For more data on advertised products, use Readers' Service Cards, last page.

What's Happening . . .

. . . in the Industry

U.O.P. To License Shell FCC Process

Universal Oil Products Company has been selected as a licensing agent for Shell Oil Company's two-stage fluid catalytic-cracking process. The process, disclosed to the industry at the American Petroleum Institute's mid-year meeting in Montreal, was developed by Shell. A 22,000-barrel-a-day unit at the company's Anacortes, Wash., refinery is the only one which has been installed.

By employing the two-stage process, a refinery can use wide boiling range stocks to crack them catalytically to high-octane gasoline while using optimum severities. This prevents over-cracking of the least refractory components to gas and coke, and under-cracking of more refractory materials.

Meanwhile, Universal Oil Products Company has organized a new department which will be responsible for the commercial application of petrochemical processes licensed by the company. This new department will function under the direction of H. W. Grote. (See What's Happening Among Men in Industry.)

New Science Series Honors Texan

First speaker in the University of Texas annual Schoch lecture series will be Warren Kendell Lewis of Massachusetts Institute of Technology. Dr. Lewis will describe recent advances in fluidization October 16 and 17 in three lectures which will be open to the public.

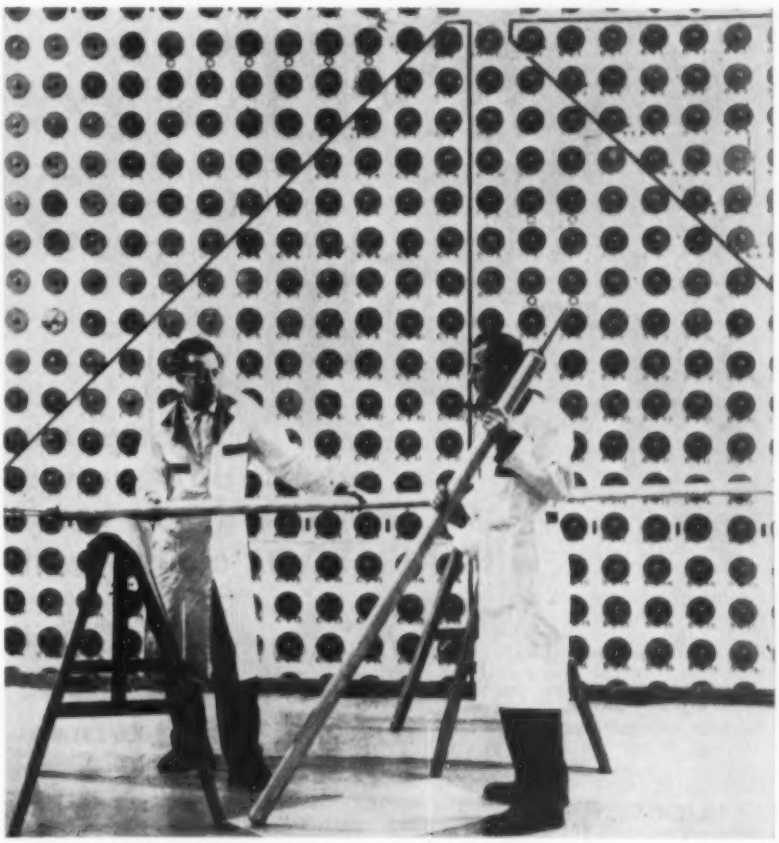
Schoch

The chemical-engineering lecture series was established this year in honor of E. P. Schoch, University of Texas professor emeritus. Dr. Schoch predicted the state's industrial boom and provided much of the technical impetus for it. He is best known for showing how Texas lignite can be used for industrial power. He also contributed much to the conservation and utilization of natural gas.

Dr. Schoch retired in 1954 after 60 years as a University of Texas faculty member. He still maintains an office at the University, however, and continues research financed by private industrial grants.

Both Lewis and Schoch have been recognized as authorities in chemical engineering since the early part of this century.

Dr. Lewis, who has taught at Massachusetts Institute of Technology since 1910, is coauthor of the first chemical-engineering textbook. He also is a consultant on fluidization and distillation problems in the petroleum-refining and petrochemical industries.



Atomic scientists from The Atlantic Refining Company's research laboratories make a final inspection of a "loop" used at Brookhaven National Laboratory before inserting it in the atomic pile.

Atlantic Installation Permits Sampling During Experiments

The Atlantic Refining Company has installed a miniature oil refinery in the atomic pile at Brookhaven National Laboratory, Upton, Long Island. By means of a "loop" reactor, which permits a continuous flow of petroleum samples through the pile, refining conditions under the influence of atomic radiation are simulated.

The "loop" consists of aluminum tubing encased in a tubular shell which is inserted into the atomic pile. Circulating and automatic control equipment outside the pile is connected to the loop, permitting samples to be taken at any time without shutting down the experiment.

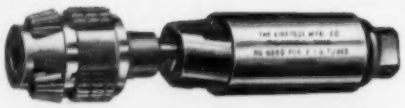
"With this continuous 'loop' we now have available for study at our Philadelphia laboratories considerably greater volumes of petroleum samples, as compared with previous radiation methods," explained H. W. Field, Atlantic's vice president and general manager of research and development.

"More important," he added, "from these results we hope to be able to make a more accurate appraisal of the economic possibilities of atomic radiation in full scale petroleum refining. It is also possible that this effort could lead us to new petroleum products not possible by any other route."

Use of the atomic pile for service irradiations has been offered by Brookhaven National Laboratory and the AEC to private concerns, and Atlantic, a pioneer in

toughest tube maintenance jobs are made easy with AIRETOOL equipment

See for yourself why so many refinery engineers specify AIRETOOL for their tube maintenance programs. AIRETOOL Equipment handles easy . . . is rugged, packs plenty of power and speed, won't bog down or break down during use. AIRETOOL does the *best* job, quickly, economically.



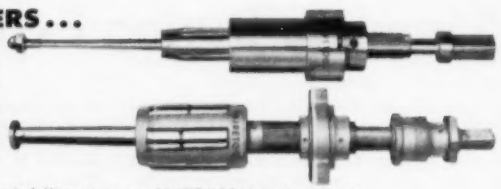
POWERFUL . . . FAST CUTTING TUBE CLEANERS quickly and thoroughly remove even hardest scale and deposits. Air driven motors in various sizes and speeds. P-Type cleaner head shown, is just one of many types available.

LIGHT . . . HANDY INTERNAL TUBE CUTTER

New . . . removes leaky or damaged tubes in *minutes!* Cuts steel or non-ferrous tubes through tube sheets 1" to 4" thick. Air or electric driven motor.

TUBE EXPANDERS . . .

Parallel rolling . . . self-feeding . . . AIRETOOL Tube Expanders roll tight, accurate tube joints with maximum bond, uniform expansion and tightness throughout full thickness of tube sheet.



Write for illustrated literature on AIRETOOL'S Tube Maintenance Equipment, or see your nearest Airetool Representative.

AIRETOOL
MANUFACTURING COMPANY
SPRINGFIELD, OHIO

BRANCH OFFICES: New York, Chicago, Tulsa, Philadelphia, Houston, Baton Rouge.
REPRESENTATIVES: in principal cities of U.S.A., Canada, Mexico, South America, England, Europe, Puerto Rico, Italy, Japan, Hawaii.
EUROPEAN PLANT: Vlaardingen, The Netherlands

What's Happening . . .

the use of atomic energy in petroleum research, has been among the first to participate.

Since early 1955 the company has been experimenting with a 1-million-volt particle accelerator.

New York Studies Air-Pollution Control

Air pollution by sulfur dioxide produced from the burning of high-sulfur-content fuel oil and attendant corrosion of surface metal is the subject of a recent New York City complaint.

Calling for more stringent control of air pollution, Frederick S. Mallette, head of the American Society of Mechanical Engineers' Committee on Air Pollution Control, named malfunctioning incinerator apparatus as the main offender in calling attention to Gotham's air-pollution problem.

Dr. Leonard Greenburg, commissioner of air pollution, speaking from a standpoint of health, has sought enactment of regulations fixing a sulfur-content limit at one or two percent for fuel oils which may be used in the city.

Three Companies Keep Two-Grade System

Shell Oil Company and Sinclair Refining Company are introducing new gasolines to replace their present premium grades.

Meanwhile, another company has announced it also will continue the two-grade marketing system. Socony Mobil Oil Company, however, will keep its "Mobilgas Special" as its top brand.

Shell will replace its premium with a new high-quality "Super Shell," and Sinclair is coming out with a stepped-up "Power-X."

All three companies have said their premium and regular grades will satisfy the requirements of all cars.

Indiana Standard Believes Crude Runs Too High

Warning of a possible collapse in the petroleum market has been issued by Frank O. Prior, president of Standard Oil Company (Indiana). Concerned about the industry's high level of gasoline stocks and volume of refinery crude runs, he has issued the following statement:

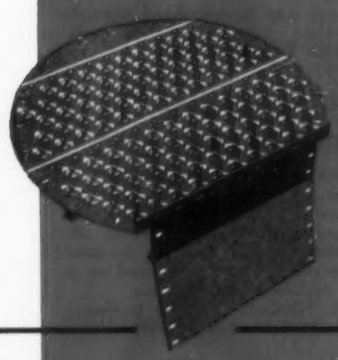
"If we are to avoid a market collapse in the near future, oil industry leaders need quickly to reexamine the volume of crude runs through their refineries. Under present operating rates gasoline stocks have been built up to excessive levels on the very threshold of the seasonal drop in demand.

"Nationally, crude runs to refineries for the past five weeks have averaged 7,983,000 barrels a day as compared with 7,572,000 during the same period of 1955, up 411,000 barrels a day. This increase is at least 200,000 barrels per day over the runs needed to meet total requirements.

"The situation varies among the districts. Compared with crude runs for the same five weeks last year, Districts 1 and 3 averaged an increase of 283,000 barrels a day, and District 2, an increase of 119,000

For more data on advertised products, use Readers' Service Cards, last page.

100% KOCH FLEXITRAYS



Another gasoline plant on the plains of Texas equipped with Koch Flexitrays. This one completely – *not a bell cap tray in the entire plant.*

In this plant for Texas Natural Gasoline Corporation in Coke County, Texas, Fluor handled the engineering, procurement, and construction for the gas compression, processing and dehydration, storage, and other facilities for 70 MMSCF/D of rich gas.

Be among the leaders to use this fine, new tray for all services – more than 160 installations to date. Wire, write, or phone us on its applications to your problems.

KOCH ENGINEERING COMPANY, INC.

DESIGNERS AND FABRICATORS OF MODERN TRAYS

321 WEST DOUGLAS • WICHITA 2, KANSAS

REPRESENTATIVES

REPRESENTATIVES

Tulsa, Oklahoma, Repr.
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Crawford Engineering Co.
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501 Alcoa Building

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Jacobs Engineering Co.
3018 East Foothill Blvd.
Pasadena 8, California

YOU GET 3 BIG SAVINGS

WITH STANDARD R-S BUTTERFLY VALVES

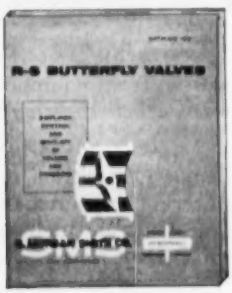
IN CATALOG 160

Based on 20 years' experience in process industry applications, R-S Butterfly Valves are now standardized. All components for those most commonly used, in sizes from 4" to 48", are carried in stock. By specifying standard R-S Valves, you now:

1. SAVE ON INITIAL DELIVERY – You can be sure of immediate service, because standard R-S Valves are ready for faster assembly and shipment.

2. SPEED REPLACEMENTS – Availability and faster delivery on standard R-S Valves can help you solve replacement problems and avoid costly, unscheduled shutdowns.

3. ELIMINATE ENGINEERING – In this new Catalog 160, you get the complete dimensions, layout drawings, specifications and materials for all pressure ratings of R-S Butterfly Valves that are now standardized. Data on operators and positioners is included. As new ratings are standardized, other sections will be published. To get a free copy and assure yourself of future sections, contact your SMS representative or write S. Morgan Smith Company, York, Penna.



S. MORGAN SMITH

HYDRAULIC TURBINES
GATES & HOISTS
TRASH RAKES
PUMPS
ACCESSORIES
HYDRODYNAMICS
ROTOVALVES
FREE-DISCHARGE VALVES
BALL VALVES
CONTROLLABLE-PITCH SHIP PROPELLERS
BUTTERFLY VALVES

AFFILIATE: S. MORGAN SMITH, CANADA, LIMITED • TORONTO

What's Happening . . .

barrels; Districts 4 and 5 would appear to be only slightly over last year.

"As a natural result of excessive crude runs, gasoline stocks are heavily out of balance with demand. As of August 17, nation wide gasoline stocks were 176,202,000 barrels, compared with 155,563,000 barrels last year, or an increase of approximately 21 million barrels. This is 15 million barrels more than stocks necessary to meet any reasonable demand requirements.

"With the season of peak gasoline demand ending, and with the seasonal peak for fuel oils fast approaching, this already bad situation could develop into a disastrous one if crude runs continue at this reckless pace. Reduced runs and product yield adjustments are clearly indicated.

"These are industry-wide figures. No one oil company is responsible for the industry situation—every company shares the responsibility. The industry figures which oil company presidents look at are the sum total of their companies' individual figures. Only individual action can change the over-all picture.

"This increasingly serious problem calls for business leadership, not in concert but through individual, independent appraisal and through commonsense, sound-business action. Such appraisal and action would be in the interests of each company, of the oil industry, and of the national economy."

Tracerlab Symposium To Cover Refining

This year's Tracerlab Symposium will be devoted to the applications of radioactivity in petroleum-industry research and refining operations. To be held in Boston's Statler Hotel October 24-26, this will be the third in a series of symposia on the industrial applications of radioactivity, sponsored by Tracerlab, Inc.

The first day will taken up by orientation talk and lectures on the fundamentals of radioactivity, the establishing of a radioactivity laboratory, Atomic Energy Commission regulations, health-physics problems, training of personnel and other basic topics. The second and third day will be devoted to the presentation of papers by speakers from industry, research laboratories, academic-research groups and the Atomic Energy Commission.

Chairman of the program for the first day will be Jerome D. Luntz, editor of *Nucleonics;* Alex G. Oblad, chairman of the Petroleum section of the American Chemical Society, will be chairman on the second day, and George B. Gibbs, editor of PETROLEUM REFINER, will be chairman on the third day.

Registration may be completed through the Symposium Committee, Tracerlab, Inc., 130 High Street, Boston 10.

Five Courses Planned For Humble Lectures

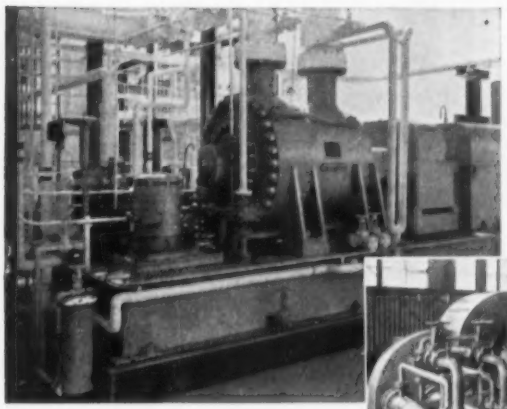
Humble Oil & Refining Company has arranged for five courses to be presented in the "Humble Lectures in Science" for technical and research personnel at its Baytown refinery. The selection of subjects for the coming year was based on a poll of the technical organization.

George E. Kimball, formerly professor of chemistry at Columbia University and

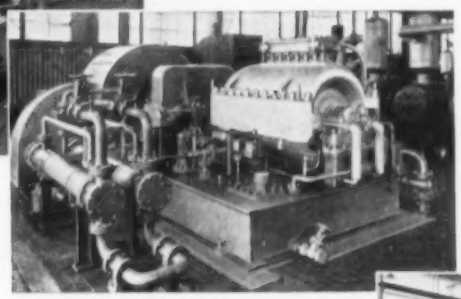
HOW 3 BASIC TYPES OF I-R

CENTRIFUGAL COMPRESSORS

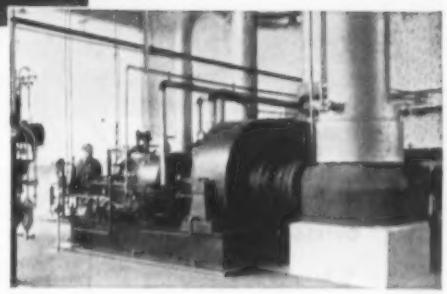
cover practically all of your process requirements



1. MULTI-STAGE VERTICALLY-SPLIT
Capacities to 9,000 cfm
Pressures to 2,200 psi



2. MULTI-STAGE HORIZONTALLY-SPLIT
Capacities to 165,000 cfm
Pressures to 625 psi

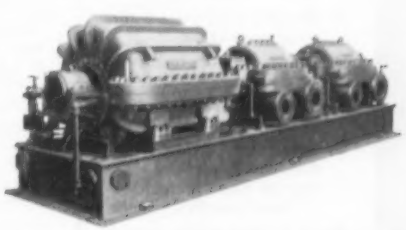


3. SINGLE-STAGE
Capacities to 255,000 cfm
Pressures to 1,000 psi

Here are the three basic types of Ingersoll-Rand centrifugal air and gas compressors. The complete range of sizes available in each type provides extremely wide latitude to meet process conditions. By combining two or more individual units of the same or different types in tandem or in series, a great range of capacities and pressures are obtainable (units up to 2,000 psi have been furnished).

Any type of drive can be used and combination units can be individually powered or driven from a single source — electric motor, steam turbine or gas turbine. This flexibility of application is one reason why more and more I-R centrifugals are being installed in all types of process service.

Ingersoll-Rand has supplied more horsepower of industrial centrifugal compressors and Turbo-Blowers than any other manufacturer. This long experience means greater dependability, higher sustained efficiency and less maintenance expense. If you have a process compression problem, call in your I-R engineer. His experience in this specialized field can save you time, effort and expense from initial planning to on-stream operation.

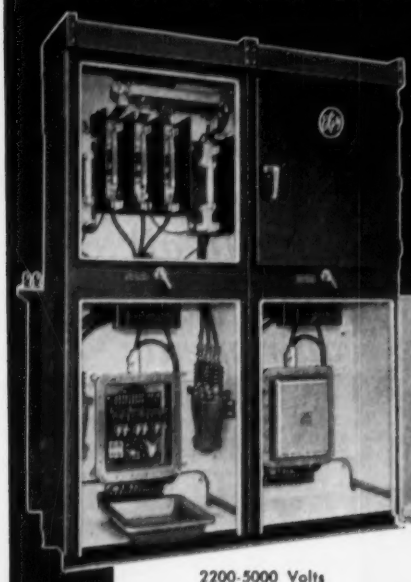


Typical series combination of three multi-stage horizontally split centrifugal compressors mounted on a single base and arranged for a common drive.

12-404

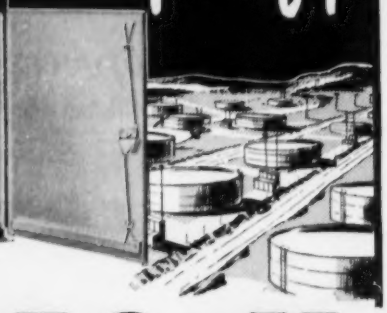
Ingersoll-Rand
11 Broadway, New York 4, N. Y.

COMPRESSORS • GAS AND DIESEL ENGINES • ROCK DRILLS • PUMPS • TURBO-BLOWERS • AIR AND ELECTRIC TOOLS



2200-5000 Volts

OIL MEN Specify:



EC&M

50,000 KVA
Interrupting Capacity
MOTOR STARTERS

Diesel-Loading pumps with EC&M Div. 2 Starters.

OUTSTANDING ADVANTAGES

1. Reduced floor space
2. Low-cost Div. 2 design
3. 50,000 KVA interrupting capacity
4. Combination starter with Disconnect Switches
5. Corrosion resistant, weather-proof construction
6. Copper tungsten contacts for positive operation
7. Simple 3-wire TIME-DELAY UVP push button circuit
8. THERMAL-MAGNETIC Overload Relays give accurate motor protection . . . trip instantly on faults
9. All internal wiring complete
10. Self-contained bus and pot-heads are optional

6733

Petroleum engineers specify these Starters for Division 2 semi-hazardous locations because they assure substantial savings in installation and operation.

Construction advantages include: Type III weather-resisting enclosure with drip-proof roof, tank-cover and front-cubicle doors . . . oil switch which opens 220-volt control transformer before upper door can be opened to operate main line disconnects . . . overload and control relays in flanged (Class I, Group D) enclosure with removable cover . . . main contactor with alloy contacts oil-immersed in rear tank. On voltage dips, push button circuit maintained up to 2 seconds by simple 3-wire circuit. "Stop circuit" opens without delay when 'Off button' is pressed.

EC&M 2200-5000 volt Starters are also available in Totally Oil-immersed Division 2 Style and in Division I style. Both are available with Oil Disconnect Switch (for main line).

Write for 16-page Booklet 1062 for complete details.

SQUARE D COMPANY
EC&M DIVISION • CLEVELAND 28, OHIO

What's Happening. . .

now with Arthur D. Little Company, will lead off in early October with a course in operations research. His course in this new field in the 1955-56 program proved so popular that it is being repeated.

Henry Taube, professor of chemistry at University of Chicago, will follow during late October and early November with a course on structure and reactions of complex inorganic compounds. Transfer of heat and mass will be the subject of J. M. Smith, professor of chemical engineering at Purdue University, the last two weeks of January.

B. H. Sage, professor of chemical engineering at California Institute of Technology, will conduct a course in engineering thermodynamics the weeks of February 18 and March 18, 1957. The series will be completed with a course on Chemistry of organic sulfur compounds by F. G. Bordwell, professor of chemistry at Northwestern University, in late February and early March. Dr. Bordwell lectured on this subject in the 1952-53 program.

Canada to Produce Hydrofluoric Acid

Another addition to Canada's growing chemical industry will be a plant The Nichols Chemical Company, Ltd., is building at Valleyfield, Queb., for the production of liquid hydrofluoric acid. The new unit, which will be the first of its kind in Canada, will turn out both aqueous and high-purity anhydrous products. At present, all hydrofluoric acid used in the country is imported from the U. S. and Europe.

Automation Conference Scheduled at Fordham

A top-management conference on data-processing automation will be held November 26-27 by Fordham University's School of Business, in cooperatin with the Third International Automation Exposition. The exposition will be held at the new Trade Show Building in New York November 26-30.

The program is designed to serve senior officers of companies which are using office automation or which are planning automation projects. Details concerning registration and the program for the two-day sessions are available from the Third International Automation Exposition, Room 359, 525 Lexington Avenue, New York 17.

Premium Octanes Recover

The nationwide weighted average for premium-grade gasoline on sale at service stations in August 97 octane numbers, up 0.1 from July. Ethyl Corporation's monthly survey shows the average for regular-grade gasoline was unchanged from the previous month's 90.1 numbers.

The premium average for August was equal to the June figure, and was up 1.1 numbers from the average for August 1955. The average for regular-grade gasoline was 1.6 numbers higher than the figure for the same month a year ago.

Of the 53 cities covered in the survey, nine reported premium averages of more than 97.5. Shreveport, La., was highest

What are your refractory castable problems ?

- High Temperatures?
- Abrasion and Erosion?
- Slag Attack?
- Overhead Applications?
- Insulating Properties Required?

B&W makes a wide range of specialized refractory castables. Whatever your problem, you will find helpful data in B&W Bulletin R-35. Send for your copy today.

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Insulating Concrete-Mixes

B&W Kaolite-20 · Kaolite-20-Gun
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For Castable Convenience Plus Insulating Effect — 13

BABCOCK & WILCOX
THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42nd ST., NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

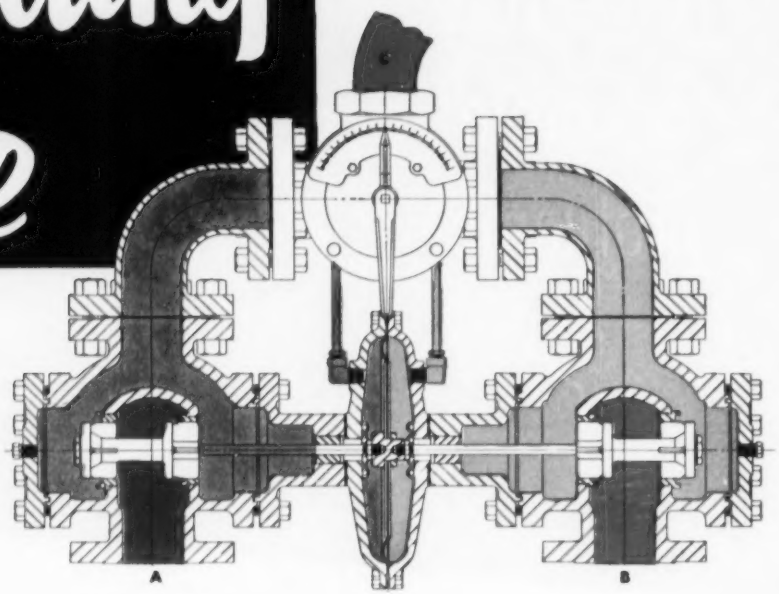
B&W REFRACTORIES PRODUCTS: B&W Alumo Firebrick • B&W 80 Firebrick • B&W Junior Firebrick • B&W Insulating Firebrick • B&W Refractory Castables, Plastics and Mortars • B&W Silicon Carbide

D-540

FISHER®

Blending Valve

AUTOMATICALLY BLENDS TWO FLUIDS IN ACCURATE DESIRED PROPORTIONS



LEGEND

FLUID A
Fluctuating Inlet Pressure

FLUID B
Fluctuating Inlet Pressure

FLUID A
Constant Equalized Reduced Pressure

FLUID B
Constant Equalized Reduced Pressure

FLUID C
Blended Fluid of Desired Characteristics

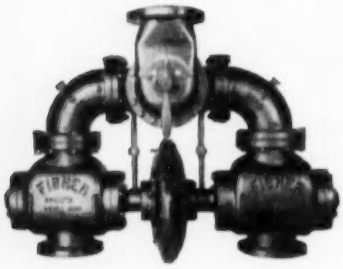
- **Eliminates necessity of measuring given quantities and batch agitation.**
- **No vapor loss in gasoline blending.**
- **Reduces blending process expense.**
- **Pointer and scale device affords simple method of accurately controlling percentages of inlet fluids to be blended.**
- **Successfully used for over 10 years.**

SPECIFICATIONS

Sizes Available—3" and 6" flanged iron or steel.

Capacities—30 to 900 gpm— 3" $C_v = 84$; 6" $C_v = 275$

Accuracy—± 1%—Pressure rating 100 psi.



The Fisher Type 430 Blending Valve will accurately blend two liquids in any proportion, holding the blend ratio constant and independent of variation in pumping pressure by action of the equalizing pressure regulator. It is suitable for blending any fluids of moderate viscosity which do not carry suspended solids and which flow at relatively constant temperature. A great number have been installed in refineries and bulk plants for blending different grades of gasoline to obtain a higher octane grade.

The blending unit employs the principle of parallel metering of the fluids through two orifices whose rates of area may be varied, while at the same time holding the pressure drop across the orifices at the same value. Thus, the ratio of the two orifices areas is in direct proportion to the bleed or ratio of the two flowing streams.

FISHER GOVERNOR COMPANY
MARSHALLTOWN, IOWA • WOODSTOCK, ONTARIO

LEADS THE INDUSTRY IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL

FISHER Since 1880

with an average of 97.8. On regular, 16 cities showed average ratings of 91 or higher, as compared to 15 cities in July. Hartford, Conn., and the metropolitan New York-New Jersey area were highest with 92.3.

U. S. Thruput Reported At 8,632,390 B/D

Crude thruput capacity of U. S. refineries increased 211,760 barrels a day last year, reaching 8,632,390 barrels a day on January 1.

An analysis by the Bureau of Mines shows three refinery districts accounted for about 90 percent of the increase. They were California, 45 percent; Texas-Gulf Coast, 31 percent, and Indiana-Illinois-Kentucky, 25 percent. Decreases in capacity were reported in the East Coast, Appalachian Area Number 1 and the Arkansas-Louisiana inland district.

The number of refineries was reduced during the year from 326 to 318, while the capacity of the average refinery was increased to 27,145 barrels a day from 25,830 barrels. There were 267,000 barrels a day of additional refining capacity under construction on January 1, and 252,200 barrels a day more was slated as replacement facilities.

About 3 percent of the nation's refining capacity, 251,589 barrels a day, was shut down on January 1. Included in this figure was 49,754 barrels a day of capacity which was believed to be inoperable without reconditioning.

The report also shows that during 1955 the capacity of U. S. cracking facilities was increased 9.5 percent.

Refinery Payrolls Double In Seven-Year Period

While the number of refineries in the U. S. has been declining, the number of employes at work in refineries has been on the increase.

The Census Bureau shows that the number of refineries dropped from 437 in 1947 to 409 in 1954. But the number of refinery workers climbed from 145,800 to 153,200, while refinery payrolls went up 52 percent from $535,800,000 in 1947 to $816,800,000 in 1954.

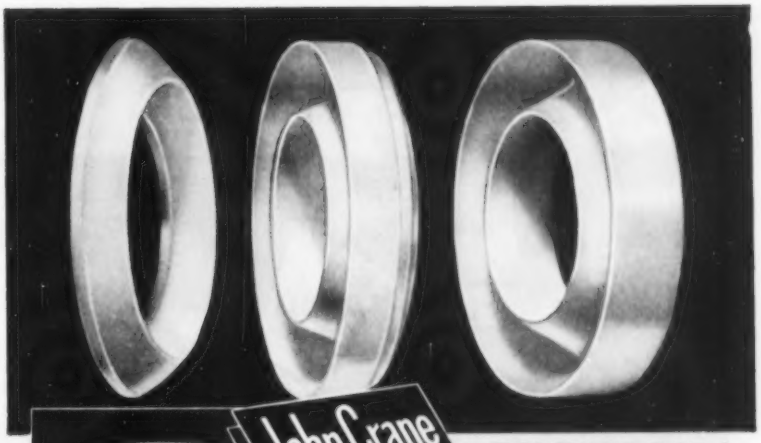
World Petroleum Assets Estimated at $63 Billion

In the ten years since World War II, the petroleum industry of the Free World has reached new highs in consumption, earnings and expenditures.

According to an analysis prepared by New York's Chase Manhattan Bank, the gross fixed assets of the entire oil industry in the Free World now stands at some $63 billion, of which about 64 percent is invested in facilities located in the U. S.

The Free World use of petroleum in 1955 reached an all-time high of 14.4 billion barrels a day. This was an increase of 10.6 percent over the consumption for 1954 and 103 percent more than the amount required in 1946.

Reporting on the 1955 earnings of 34 major U. S. oil companies, the bank's analysis shows the group experiencing its most profitable year. These companies,



John Crane

CHEMLON *

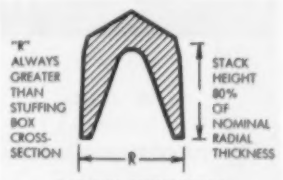
C-V RINGS

ARE INDUSTRY'S MOST UNIVERSAL PACKING . . .

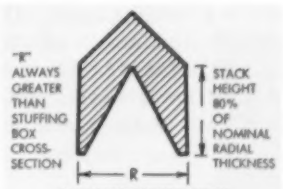
Countless successful applications of C-V Rings under the most severe service conditions have made this the closest approach to a universal packing.

It will effectively handle all industrial acids, alkalis, solvents, organic and hydraulic fluids . . . temperatures from −120°F. to +500°F. . . . is equally suited to valves, pumps, mixers, hydraulic cylinders and like equipment.

"John Crane" C-V Rings have extremely low coefficient of friction. "Breakout" friction is only slightly higher than running friction.



C-VU RING CONSTRUCTION



C-VH RING CONSTRUCTION

TWO STYLES ARE AVAILABLE:

C-VU RINGS *for low pressure service* —such as control and regulator valves handling gases and fluids, where it is necessary to have a very sensitive and resilient type packing.

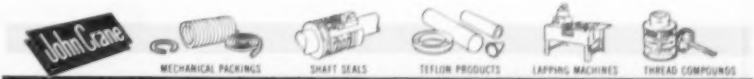
C-VH RINGS *for high pressure service* —for use in pumps, hydraulic cylinders and like services at pressures ranging to 500 psi. and over. These rings are constructed with a heavy wall heel to withstand pressure requirements. They are designed to provide voids between rings, so that as the Teflon expands due to heat, this take-up room minimizes any excess friction in the stuffing box.

"John Crane" C-V Rings are available in full line of standard sizes and male and female adaptors. Sizes can be molded to stuffing box specifications.

Request Bulletin T-110.

*"John Crane" C-V Rings are made from Chemlon—*the best in DuPont Teflon.*

Crane Packing Co., 6420 Oakton St., Morton Grove, Ill. (Chicago Suburb). *In Canada: Crane Packing Co., Ltd., Hamilton, Ont.*



CRANE PACKING COMPANY

For more data on advertised products, use Readers' Service Cards, last page.

ÆSOP'S FABLES No. 3

Emerging from the marshes, the Quack Frog proceeded to announce to all the animals that he had a medicine for curing any disease, or for making one stronger and handsomer. Up spoke the Fox: "Ha, all you do is croak and quack all day . . . you don't really expect us to believe you can cure others when you cannot even heal your own bulging eyes, ridiculous legs and blotched, wrinkled skin?"

With this, Quack Frog immediately hopped back into the bog from whence he had come.

Moral:

Eventually, false claims or cure-alls are labelled as "Quack."

. . . there is, however, a "cure-all" when it comes to the bonding of fire brick . . . famous ADAMANT, the *original* high temperature cement, is literally *unbeatable* as a bonding agent. ADAMANT joints are gas-tight, metal-tight, withstand vibration . . . effectively resist abrasive action of dust-laden air . . . and, ADAMANT sets without shrinking or cracking . . . maintains its bond throughout temperature range. Our new Bonding Mortars bulletin #3 will gladly be sent on request.

Botfield

ESTABLISHED 1907

REFRACTORIES

ADAMANT and other ADA products

swanson and clymer sts.
philadelphia 47, penna.

What's Happening. . .

which refined about 65 percent of the Free World's petroleum supply in 1955, had earnings of $2668 million, as against $2319 million for the previous year.

The group paid out $1117 million in cash dividends in 1955, or 41.9 percent of its earnings. Stock and other dividends totalled $366 million. By contrast, these companies declared cash dividends of $991 million in 1954.

Capital expenditure by the group amounted to $3905 million in 1955, also a new record. The same companies spent $3669 million in 1954.

This capital program climaxed ten years of expansion in the Free World industry by U. S. companies. In the decade 1946-55, the group analyzed spent a total of $27.5 billion for improving its facilities both in the U. S. and other countries.

Two Caltex Refineries Receive Safety Awards

Two Caltex refineries, one at Batanga operated by Caltex (Philippines) Inc., the other at Pernis near Rotterdam operated by Caltex Petroleum Mij (Nederland) N. V., have won awards for outstanding safety records. Awards granted by the National Safety Council cited the completion by Batangas employees of one million man hours without a single accident, and significant reduction of frequency of disabling injuries at Pernis.

Stauffer Expands Niagara Facilities

Stauffer Chemical Company is expanding its Niagara Falls facilities for the manufacture of titanium tetrachloride. The company is completing an expansion which about doubles the facilities it had in Niagara Falls in late 1955. And a new program, which is scheduled for completion early in 1957, will quadruple the company's capacity of a year ago. The tetrachloride is used as a catalyst in the production of such plastics as polyethylene.

Bureau of Standards To Relocate in Maryland

National Bureau of Standards has selected Gaitherburg, Md., for the new location of its Washington laboratories. The move will permit the bureau to plan new buildings to replace its existing facilities, which have been in use by the bureau since 1903. The laboratories in Washington have been judged inadequate for current needs.

Indiana Standard Starts Chemical Reorganization

Amoco Chemicals Corporation will be the name of a company resulting from the proposed consolidation of three chemical subsidiaries of Standard Oil Company (Indiana). Jay H. Forrester will become president of the new corporation when the companies are consolidated late this year. *(See What's Happening Among Men in the Industry.)*

The first step in the reorganization of Indiana Standard's chemical affiliates was

PUMP!

THE EMPHASIS IS ON U . . .

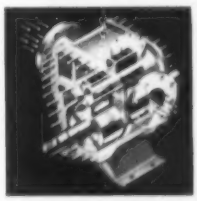
WHEN DESIGNING Kinney® HELIQUAD

AND ROTARY PLUNGER PUMPS!

- **Unique designs based on soUnd engineering principles!**
- **Underrated or conservative capacity ratings . . . to handle Unexpected overloads!**
- **Unfailing performance — trUly dependable service to minimize downtime!**

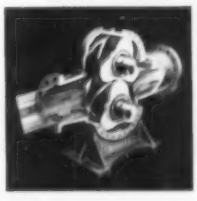
. . . and the most important one — YOU! These pumps are designed to make YOUR process more profitable. YOU'LL recognize their design superiority when the pumping assignment is a really tough one. Many exclusive features (oversized suction and discharge openings, extra large shafts and bearings, external anti-friction bearings, etc.) contribute to the long life, high efficiency, and application flexibility that characterize the Kinney Liquid Pump line. Request complete details.

MODEL SD ROTATING PLUNGER PUMP



For viscous fluids (asphalts, heavy oils, grease, emulsions, acid sludge, etc.) . . . can be used to meter or proportion fluid pumped. No valves, blades, springs, or vanes. Models range from 1½ GPM to 500 GPM and working pressures from 70 to 250 psi.

MODEL HQ HELIQUAD ROTARY PUMP



Unique heliquad rotors assure continuous, non-pulsating fluid delivery over a wide viscosity range (from gasolines or solvents to heavy oils or residuals). Bearings and timing gears external to pumping chamber. Capacities up to 2500 GPM and pressures up to 300 psi.

Write Now!

Write today for your copy of Bulletin L51A which describes the complete line of Kinney Liquid Pumps . . . or contact one of our competently staffed offices in Baltimore, Charleston, W. Va., Charlotte, N. C., Chicago (La Grange), Cleveland, Detroit, Houston, Los Angeles, New Orleans, New York, Philadelphia, Pittsburgh, San Francisco, St. Louis . . . or The International Sales Office, 90 West St., New York 6, N. Y.

KINNEY MFG. DIVISION
THE NEW YORK AIR BRAKE COMPANY
3596 WASHINGTON STREET • BOSTON 30 • MASS.
INTERNATIONAL SALES OFFICE, 90 WEST ST., NEW YORK 6, N.Y.

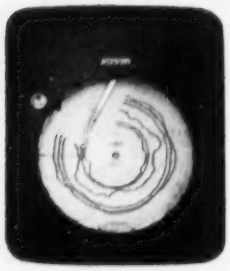
*Please send Bulletin L51A describing Kinney Liquid Pumps

Name _____
Title _____
Company _____
Street _____
City _____ State _____

For more data on advertised products, use Readers' Service Cards, last page.

GET THE BEST SOLUTION TO ANY TEMPERATURE

with Foxboro

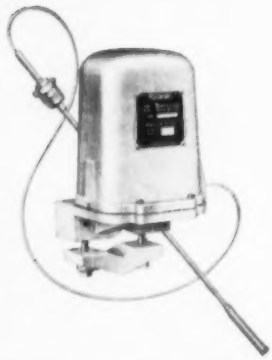


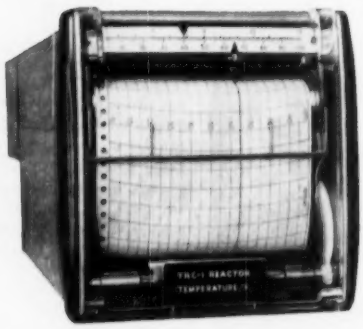
Dynalog Electronic Instruments

Complete line of indicators, recorders, and controllers employing the advanced Dynalog measuring system in which a friction-free air capacitor replaces conventional slide-wire — provides continuous, stepless balancing action. Dynalog Instruments provide up to six records on a single round chart. For use with resistance or voltage type primary elements — pneumatic or electric control action.

Multi-Record Dynalog

- 6 color-coded temperature records on one round chart.
- Each record line a distinctive, non-smudging color.
- No slidewire — no batteries — no standardizing.
- Thermocouple or resistance bulb types.





Consotrol Recording Control Station

One of the complete Consotrol line of compact panel indicators, recorders, and controllers. This advanced control station features full 4" chart and scales, six-months' ink supply, bumpless auto.-man. transfers. The M/58 Consotrol Controller, shown here integrally mounted, provides:

- All four control actions, with two reset ranges, easily adjustable to widest variations in operating conditions.
- Easy lever-setting proportional band, calibrated to 500%.
- High sensitivity and precision due to unique "floating disc" balancing action — even at widest settings of proportional band.
- Interchangeable "plug-in" components.
- Continuously variable reset resistance gives 500:1 rangeability.

PRIMARY ELEMENTS

A complete selection of primary elements for filled thermal systems, resistance bulbs, and thermocouples. Besides standard and thermocouple types, special elements and accessories are available to meet the requirements of virtually any industrial application.

Dynatherm Resistance Bulb

For use with Dynalog Electronic Instruments.

- Superior measurement performance for temperature up to 600°F.
- Fastest response due to positive metal-to-metal end contact with standard wells or sockets.
- Highest sustained accuracy. Permits use of extra-narrow scales — ideal for precise temperature difference measurements.

Roll Surface Temperature Element

- Continuous, automatic measurement or control of roll surface temperatures up to 450°F.
- Extra-rugged construction — with a "feather" touch. Won't mark or score the roll.
- Eliminates friction, radiation, and convection errors.
- Simplest, most accurate way to measure roll surface temperatures.

PROBLEM | from −450°F to +2800°F

Instrumentation

Model 12A Temperature Pneumatic Transmitter

- Simple way to measure remote temperatures in the −100°F to +1000°F range. Operating spans of 50°, 100°, 200°, and 400°F.
- Compensated for ambient temperatures and pressures.
- Compact, easily installed. Uses regular ¼" O.D. tubing transmission lines — no troublesome conduits, no costly capillary tubing.
- Suitable for any hazardous, corrosive, or outdoor location.

Electric Proportional Action Controller

- Can be used with any Foxboro measuring system — mechanical or electrical.
- Precise, frictionless control action through electronic relay and electric valve operator.
- 3 types of proportional control action available.
- Setting knob permits easy, stepless adjustment of control band throughout range of instrument.

Whenever you have a temperature problem in the −450°F to +2800°F range, you can depend on Foxboro Instrumentation for the best solution. Foxboro's outstanding combination of truly advanced instruments and unequaled experience in applying them, has successfully solved temperature problems as widely different as helium liquefaction and jet engine testing. Foxboro offers a wide variety of primary elements, transmission devices, indicators, recorders, and controllers. Whether a single instrument or a combination is required — filled-system, electronic, or electric — you can be sure of fitting the process *exactly*. Unique Foxboro developments, such as Dynalog* Electronic Instruments, Dynatherm** Resistance Bulbs, and the 12A Temperature Transmitter, continually maintain control standards in step with every advance of modern processing. A few of the instruments which typify Foxboro's better-engineering are shown on these pages. Chart below shows complete temperature ranges covered by Foxboro measuring systems. Write for complete details. **The Foxboro Company, 749 Neponset Ave., Foxboro, Mass.**

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

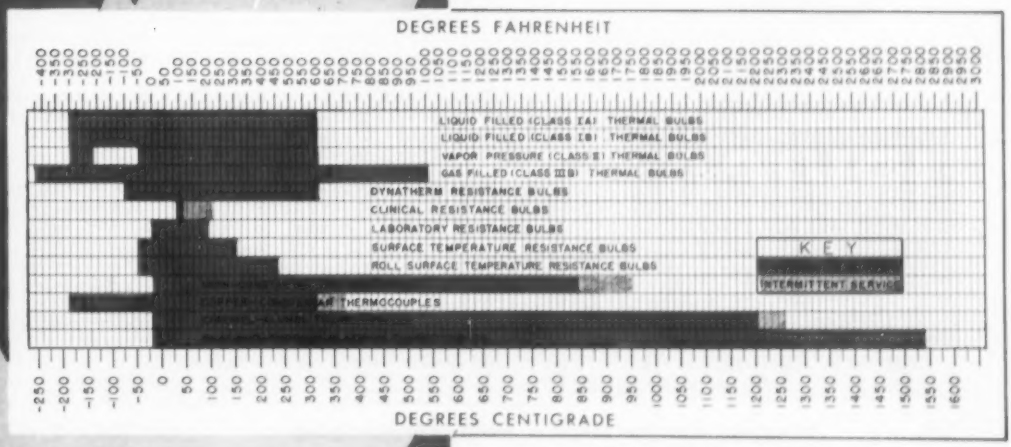
FOXBORO

Reg. U.S. Pat. Off.

TEMPERATURE

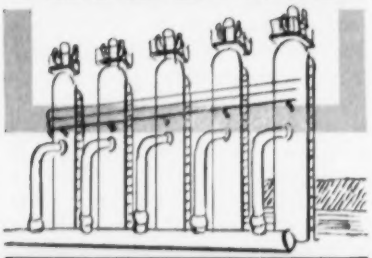
measurement and control

Locate your problem temperature in this table



*Reg. U.S. Pat. Off. **Trademark

FEWER "TURN-AROUNDS"



Shutdowns for repairs of fire clay linings in refractory units are expensive. The frequency and duration of these shutdowns can be greatly reduced by the use of a steel grating armor known as "Gridsteel", which holds the castable refractory linings in place longer and armors them against the bombardment of catalytic elements.

"Gridsteel" is available in a special loose clinch to conform easily to curved surfaces.

For complete information, write for brochure on Irving "Gridsteel" Contour Retainer Mesh

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"A Fitting Grating for Every Purpose"

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IRVING SUBWAY GRATING CO., Inc.
Originators of the Grating Industry

Offices and Plants at
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What's Happening . . .

taken with the renaming of Hidalgo Chemical Company. Under its new name, Amaco Chemicals has qualified to do business in all 48 states.

Besides the former Hidalgo Chemical Company, which headquarters in Tulsa, the subsidiaries being consolidated are Indoil Chemical Company, a Chicago concern, and Pan American Chemicals Corporation, which has offices in New York.

The chemical consolidation is part of a recently-announced functional reorganization of nine Standard Oil Company (Indiana) subsidiaries into four. When it is completed, Amoco Chemicals Corporation will have its main offices in Chicago.

Electric Bond & Share Acquires Chemico

Chemical Construction Company has been sold to Electric Bond & Share Company. Formerly an affiliate of American Cyanamid Company, it was sold for an undisclosed amount. Plans call for Chemico, a designer and builder of chemical plants, to be operated as a separate unit.

IRAA Files Protest Against UOP Sale

Independent Refiners Association of America has filed a protest with the New York supreme court opposing the sale of Universal Oil Products Company.

M. H. Robineau, president of the association, said the technological services provided by Universal are vital to the independent refining industry. He fears that, under the proposed sale, independent refiners would lose this service.

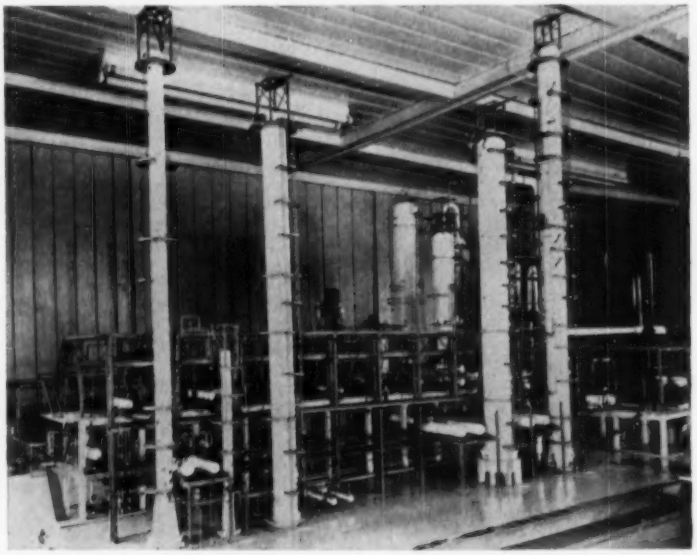
Guaranty Trust Company of New York, trustee of The Petroleum Research Fund, which holds UOP securities, has asked the court for authority to sell the securities.

The association has protested the sale also to the Justice Department. And Senator Sparkman, chairman of the Senate Small Business Committee, has asked the department to make a close study of the proposed sale.

Changes Firm Name

The corporate name of Escambia Bay Chemical Corporation has been changed, and permanent offices established. The

Shell Miniature Cuts Costs



A scale model of a second catalytic-cracking plant is being used as a three-dimensional blueprint at the Pernis refinery of N. V. Bataafsche Petroleum Maatschappij in The Netherlands. Built of Wood, plastic and copper to a scale of one in 50, the model allowed Shell technologists to study the plant and layout of pipe before construction was started. This avoided alterations once the project was underway. Later, the model was used for planning the erection of shear legs when large components were being hoisted into position.

The model is built in three parts: the catalytic cracker itself with fractionating tower, the distillation unit in which the feed is prepared and the gas treater. These are mounted on separate tables which can be placed together for studying the complete plant.

Despite its $19,000 cost, the model proved economical, permitting a savings in drawings, pipe work and painting. With the model, however, about 4000 drawings still were required to build the cracking unit. One advantage of the model is that by studying it contractors were able to make more accurate estimates, turning in tenders on an average of at least 10 percent less than would have been expected.

HIGH ABOVE ALL OTHER STANDARDS!

The Newly MODIFIED* Hammel-Dahl Standard 3000 Series CONTROL VALVE

Now incorporates the following *additional* features:

1. Retained gasket design for bonnet and blindhead joints.
2. One-piece construction bonnets and blindheads.
3. Cast ductile iron open-yoke.
4. Pressed steel diaphragm casings and steel spring barrel.
5. Four spring ranges interchangeable in any superstructure: 0-30, 3-15, 5-25, or 6-30 PSIG.
6. Superstructure removable without disturbing the stuffing box or the gland flange bolting.
7. Oversize diaphragm case interchangeable with standard case.
8. Plug stem — spring stem split — coupled. (Simplifies assembly and disassembly, and prevents twisting of the plug stem.)
9. Integral mounting bracket for all makes of positioners on all superstructures.
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COMPLETE Information in Bulletin 101-D

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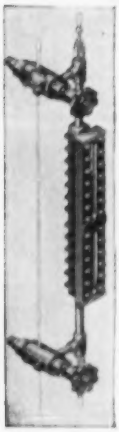
For more data on advertised products, use Readers' Service Cards, last page.

How to Solve Problems of ACCURATE GAGING

of levels and pressures when liquids are

COLD and SLOW or HOT and FAST

Whether you handle liquids whose flow is "slow as cold molasses," or which boil and surge so they're hard to gage, Jerguson can solve your problems of accurate liquid level and pressure gaging.



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Specially designed to carry a circulating medium . . . heated to speed up the flow of slow, cold liquids . . . cooled to slow down boiling or surging liquids. Give you accurate liquid level readings, without tracing.

Jerguson Heated or Cooled Valves for Pressure Gages

Jacketed design with built-in tracing. Cold, heavy liquids flow so you get accurate pressure readings. Special design reduces threaded connections; combines unions, nipples, etc. in one compact unit. Ideal for cold services, waxes and other heavy materials.

Jerguson Gages and Valves now available with Electric Heating. Ask for special details.

Write for Data Units: #237 on Heat-Cooled Gages; #252 on Valves for Pressure Gages, etc.

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What's Happening. . .

company has discontinued the use of the word "Bay" in its firm name to become Escambia Chemical Corporation.

Executive offices of the corporation now are at 261 Madison Avenue, New York. Its research and development activities will be carried on at Cambridge and Newton, Mass. And its production facilities are the new petrochemical plant at Pensacola, Fla.

Coal Industry to Use Petroleum Processes

Jones & Laughlin Steel Corporation has plans for using advanced petroleum-refining techniques for the first time in the steel industry. Refining facilities costing more than $2 million will aid in the production of coal chemicals.

Esso Research and Engineering Company has licensed Jones & Laughlin to use its Hydrofining process for the removal of sulfur. And Universal Oil Products Company licensed the company to build a Udex unit for the final purification and removal of all remaining non-aromatic impurities.

The combination of these processes will purify the chemicals produced from all Jones & Laughlin's by-product coke-oven operations. The plants will be installed at the company's Aliquippa, Pa., works. They will be completed early in 1957. The Badger Manufacturing Company is prime contractor in charge of engineering and construction.

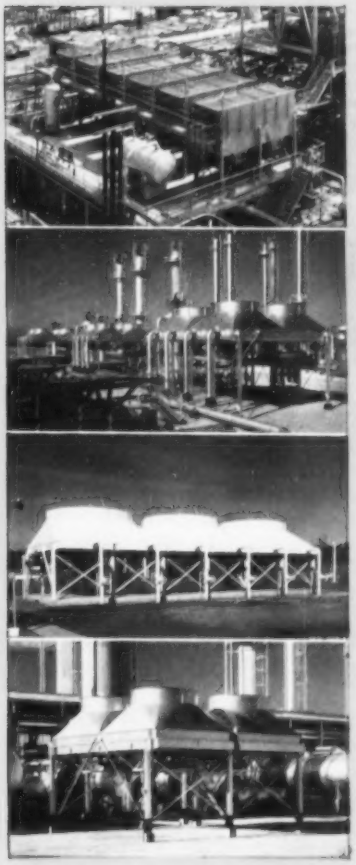
Consumption of the light oils produced as byproducts of the coking of coal has been rising rapidly. For instance, benzene production has increased from 30 million

MEETINGS CALENDAR

SEPT.	
12–14	National Petroleum Association, Annual Meeting, Traymore Hotel, Atlantic City.
16–21	American Chemical Society, Annual Meeting, Atlantic City.
16–22	National Society for Testing Materials Pacific Area National Meeting and Apparatus Exhibit, Statler Hotel, Los Angeles.
17–19	American Institute of Electrical Engineers, Annual Electrical Conference of the Petroleum Industry, Kansas City, Mo.
17–21	American Society of Mechanical Engineers, Instruments and Regulators Division and Instrument Society of America Exhibit and Joint Conference, Coliseum, New York.
17–21	Annual Instrument-Automation Conference and Exhibit, Sponsored by the Instrument Society of America, Coliseum, New York.
20–21	National Association of Corrosion Engineers, Annual Corrosion Control Short Course, Centenary College, Shreveport.
20–21	Mid-Continent Oil and Gas Association, Louisiana-Arkansas Division Roosevelt Hotel, New Orleans.
20–21	Mid-Continent Oil & Gas Association, Louisiana-Arkansas Meeting, Hotel Roosevelt, New Orleans.
20–21	Western Petroleum Refiners Association, Technical Industrial Relations Meeting, Henning Hotel, Casper, Wyo.
16–22	American Society for Testing Materials, National Meeting and Apparatus Exhibit, Hotel Statler, Los Angeles.
23–26	American Society of Mechanical Engineers, Petroleum Mechanical-Engineering Conference, Conrad Hilton Hotel, Dallas.
24–26	America Oil Chemists' Society, Sherman Hotel, Chicago.
24–28	Trade Fair of the Atomic Industry, Sponsored by the Atomic Industrial Forum, Navy Pier, Chicago.
26–28	Chemical Market Research Association, Chateau Frontenac, Quebec City, Quebec.
28	Natural Gasoline Association of America, Oklahoma Regional Meeting, Skirvin Hotel, Oklahoma City.
OCT.	
1– 3	Texas Mid-Continent Oil & Gas Association Annual Meeting, Rice Hotel, Houston.
1– 5	American Institute of Electrical Engineers, Fall General Meeting, Morrison Hotel, Chicago.
2– 4	Chemical Industry Corrosion Conference, Sponsored by The International Nickel Company, Wrightsville, Beach, N.C.
8–10	American Society of Mechanical Engineers—American Society of Lubrication Engineers, Third Lubrication Conference, Chalfonte-Haddon Hall, Atlantic City, N.J.
11–12	California Natural Gasoline Association, Annual Fall Meeting, Huntington-Sheraton Hotel, Pasadena, California.
11–13	American Chemical Society, Louisiana Section, Jung Hotel, New Orleans.
14–20	Oil Progress Week
15–17	National Association of Corrosion Engineers, Northeast Regional Meeting, Drake Hotel, Philadelphia.
18–19	Western Petroleum Refiners Association, Regional Technical-Industrial Relations Meeting, Rufus Garrett Hotel, El Dorado, Ark.
22–24	National Lubricating Grease Institute, Annual Meeting, Edgewater Beach Hotel, New York.
23	Association of Consulting Chemists and Chemical Engineers, Annual Meeting and Symposium, Belmont Plaza Hotel, New York.
23–26	National Association of Corrosion Engineers, South Central Regional Meeting, San Antonio.
24–25	American Society of Mechanical Engineers—American Institute of Mining and Metallurgical Engineers, Joint Fuels Conference, Sheraton-Park Hotel, Washington, D.C.
26	Natural Gasoline Association of America, Southern Regional Meeting, Captain Shreve and the Washington-Youree Hotels, Shreveport, La.
29–30	Independent Petroleum Association of America, Annual Meeting, Statler Hotel, Dallas.
NOV.	
1	Commercial Chemical Development Association, Cincinnati.
1– 2	Society of Automotive Engineers, National Diesel Engine, Drake Hotel, Chicago.
1– 2	Fifth Annual Instrumentation Conference, Sponsored by Louisiana Polytechnic Institute, Ruston, Louisiana.
7– 8	Symposium on Process-Data Logging, Sponsored by the Instrument Society of America, Bellevue-Stratford Hotel, Philadelphia.
8– 9	National Association of Corrosion Engineers, Southeast Regional Meeting, Charlotte, N.C.
8– 9	Society of Automotive Engineers, National Fuels and Lubricants Meeting, Mayo Hotel, Tulsa.
12–15	American Petroleum Institute, Annual Meeting, Conrad Hilton Hotel and Palmer House, Chicago.
15–16	National Association of Corrosion Engineers, North Central Regional Meeting, Detroit.
26–27	Third International Automation Exposition, Trade Show Building, New York.
26–30	National Exposition of Power and Mechanical Engineering, Sponsored by the American Society of Mechanical Engineers, Coliseum, New York.
27–30	American Chemical Society, National Chemical Exposition, Cleveland, Ohio.
30	Natural Gasoline Association of America, Panhandle Plains Regional Meeting, Herring Hotel, Amarillo, Texas.

HUDSON LEADS THE WAY In Equipment For Cooling with Air

More than 600 HUDSON Solo-aire and Combin-aire Units are giving complete satisfaction both in mechanical operation and in meeting cooling performance specifications in . . .



OIL REFINERIES

Solo-aire Units, installed in space formerly occupied by water box submerged coolers, are used for condensing and oil cooling, eliminating water circulation of 4200 gallons per minute. Previous high maintenance costs due to water scaling and corrosion are also eliminated.

GAS PROCESSING PLANTS

Solo-aire Units as pictured at left, and Combin-aire Units, are minimizing water consumption, lowering water treatment costs, and lowering over-all maintenance expense in scores of Gas Processing Plants in the United States, Europe, Pakistan and South America.

COMPRESSOR STATIONS

Solo-aire Units are installed in many of the larger main line Compressor Stations in the United States for cooling gas, jacket water, and lube oil. HUDSON auto-variable pitch fans allowing accurate, automatic control of cooler outlet temperature are used in many of these installations.

CHEMICAL PLANTS

Vapor at 550°F. is condensed and condensate subcooled in Solo-aire pictured at left. In services for cooling of very high temperature fluids, and cooling of fluids with which water contamination must be avoided, Solo-aires are particularly adapted.

Experience The first HUDSON exchangers using air as the cooling medium were installed over 20 years ago for condensing exhaust steam. Thru constant research, improvement and innovation in design and in manufacturing techniques, and in development of units for special applications, HUDSON reached and has retained its position of leadership in "Cooling with Air."

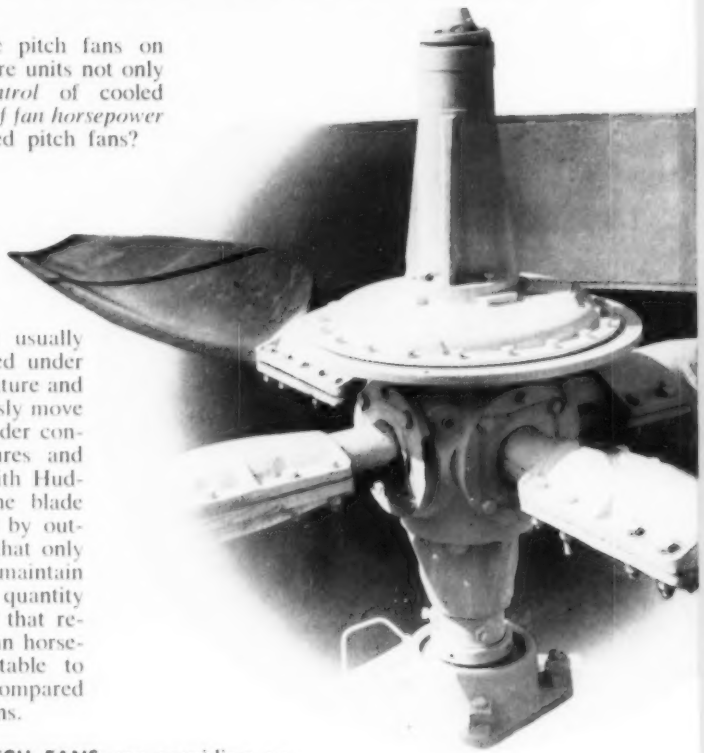
HUDSON

ENGINEERING CORPORATION

FAIRVIEW STATION • HOUSTON, TEXAS

LARGE POWER SAVINGS
and Accurate, Automatic Temperature Control
with HUDSON AUTO-VARIABLE PITCH FANS

WHY do Hudson Auto-variable pitch fans on Hudson Solo-aire and Combin-aire units not only *give accurate temperature control* of cooled streams, but — *save up to 85% of fan horsepower* compared with conventional fixed pitch fans?



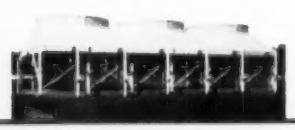
BECAUSE fixed pitch fans are usually selected to move the air required under conditions of summer air temperature and maximum heat load, and needlessly move such maximum quantity even under conditions of winter air temperatures and lower-than-design heat loads. With Hudson Auto-variable pitch fans the blade pitch is automatically controlled by outlet cooled fluid temperature so that only the quantity of air required to maintain this temperature is moved. This quantity in winter may be only 30% of that required in summer, resulting in fan horsepower saving of 85% attributable to Auto-variable pitch fans as compared with conventional fixed pitch fans.

OVER 200 AUTO-VARIABLE PITCH FANS are providing accurate, trouble-free temperature control in Hudson Solo-aire and Combin-aire units. Minute changes in cooled fluid outlet temperature immediately and automatically changes pitch of fan blades, increasing or decreasing flow. Control is effective despite changes in heat load or hot fluid inlet temperature; and over ambient air temperature range of more than 150° F.

Consult Hudson for more detailed information on the application of Auto-variable pitch fans to present or future installations.

HUDSON AUTO-VARIABLE PITCH FANS

- **Accurately control temperature.**
- **Effect major savings in power.**
- **Reduce cost of control equipment.**
- **Eliminate by-pass piping.**
- **Prevent freezing even in extremely cold weather.**
- **Operate with standard pneumatic instruments.**
- **Have all moving parts of control mechanism completely enclosed and weather-proofed.**



HUDSON
ENGINEERING CORPORATION

FAIRVIEW STATION • HOUSTON, TEXAS

What's Happening . . .

gallons a year in 1938—when the only source was coal—to more than 300 million gallons this year. Coal currently supplies about two-thirds of this volume, with the remainder coming from petroleum.

Champlin Installs Digital Computer

Champlin Refining Company has acquired a digital electronic computer to increase the efficiency of its refining operation. The unit, which was purchased from Logistics Research, Inc., at Redondo Beach, Calif., will compute the cost per barrel of gasoline and permit the company to find the optimum of efficiency on any project within a few minutes.

In computing price per barrel, the unit can "remember" details of graphs relating to limiting vapor pressure, required octane number of the output and the effects of adding tetraethyllead to different base stocks. It can store up and obey sequences of up to 16,000 instruments, and calculate problems of any complexity, in any desired sequence.

Sinclair Plans to Buy Minnesota Refinery

Sinclair Oil Corporation is considering a plan for its subsidiaries to purchase the properties of Southern Production Company, Inc. The purchase, which would be according to a plan for the complete liquidation of Southern Production, is subject to several conditions, including the approval of stockholders. If the plan is carried out, the assets to be acquired by Sinclair will include a recently-completed refinery near St. Paul, Minn., with a daily capacity of 25,000 barrels.

Program to Boost Interest In Science

Manufacturing Chemists' Association, Inc., has launched a nationwide education program designed to encourage more students to take up the study of science. The program, which will include work at elementary, high-school and college levels, is expected to cost $1 million over a five year period.

A study conducted by the association shows that by 1965 the U. S. will be short 457,000 engineers and scientists. The chemical industry alone will be short 93,000 scientists and engineers.

Acquires Full Control

Standard Oil Company (Indiana) is acquiring full ownership of Utah Oil Refining Company. Standard previously has held a 70-percent-interest in the Salt Lake City concern.

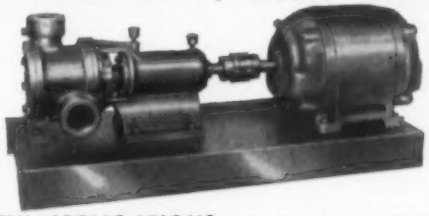
Lion Takes Safety Award

Lion Oil Company, a division of Monsanto Chemical Company, has received an Award of Honor from the National Safety Council for accident-prevention records set by Lion employes during 1955.

The award, which is the highest recognition for industrial-safety achievement made by the council, was presented to Lion for "outstanding safety performance." Lion's company-wide accident-frequency

handle those difficult jobs with

AURORA® APCO *Process* PUMPS



NEW APPLICATIONS—the handling of liquefied petroleum gases, refrigerants and other light non-viscous liquids are easy for APCO Z4 Pumps.

SPECIAL METALS—APCO Z4 Pumps are obtainable in any machineable alloy. The small amount required of such metal represents a real economy.

PERFORMANCE FEATURES—of the APCO Pump are ideal for the type of process duties for which the APCO Z4 Pumps were designed.

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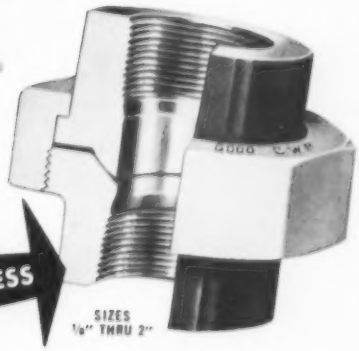
FORGED STEEL UNIONS
Ideal for High Pressures of Gases or Liquids, Hot Oils, High Temperatures, Ammonia Hot or Cold & Power Piping



HEAVIER WALL THICKNESS

SIZES 1/8" THRU 2"

● The wall thickness of this New Petro Union has been greatly increased to easily withstand the severe demands of higher pressures and hot or cold temperatures. It is drop forged from uniformly heated steel forging bars. Grain and fibre structure are refined through the controlled hammer impact on the hot, plastic metal as it is confined in the closed dies. The hot forging develops the tensile and torsional strength, the toughness and fatigue endurance required to enable the finished Union to resist the most complex stresses and strains ever present in high pressure and high temperature piping systems.
● Nuts are octagon in shape and are Udylited. The nut threads are rust-proof, spark-proof and permanently lubricated with Udylite Cadmium.
● The ends are also octagon in shape to provide flat gripping areas for wrenches.
● The ends are tapped, sharp and clean, per American Standard B 2-1 1945 (for tapered pipe threads).

THE "ECONOMY PLUS" UNION

You'll get greater ruggedness, dependability and service with a minimum of downtime or maintenance time. Considering the original low cost it's the most economical Union you will ever buy.

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For more data on advertised products, use Readers' Service Cards, last page.

Here Is A *Proven* Answer
To Sulfide Scale Formation in Reforming Units

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ALUMI-SPRA®

The ALUMI-SPRA® process* is a NEW diffused-coating type of aluminizing.

Recent refinery tests show that ALUMI-SPRA® coating is not affected by H_2-H_2S corrosion in furnace tubes and feed lines in reforming service.

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* Patent pending

rate in 1955 was 68 percent better than the standard established by the National Safety Council for the top honor, and the company's accident-severity rate was 92 percent better than the council's par.

India Eyes Profits Of Three Refineries

The Indian government is studying the profits of three foreign-owned refineries in India to see if they are making any drain on the country's finances that could be avoided. This was revealed in the lower house of Parliament after a Communist delegate from Bengal charged the refineries were making huge profits and demanded that they be nationalized.

In reply to the Bengal delegate, the government's Minister for Works, Housing and Supply said it was too soon to consider whether the concession the government had granted these companies were excessive. Pointing out that the refineries had been in operation only about a year, he said the question should be raised only after the refineries had settled down to normal business.

The government spokesman felt that if the refineries were found to be making more than a reasonable profit, the companies could be persuaded to lower their prices. In fact, he said, they probably would make the readjustment voluntarily.

French to Use Atom In Petroleum Research

Compagnie Francaise de Raffinage will install a 2-million-volt Van de Graaff particle accelerator at its laboratory in Paris. The unit was acquired in the U. S. from High Voltage Engineering Corporation. It will be used in fundamental research studies in the effect of radiation on petroleum products.

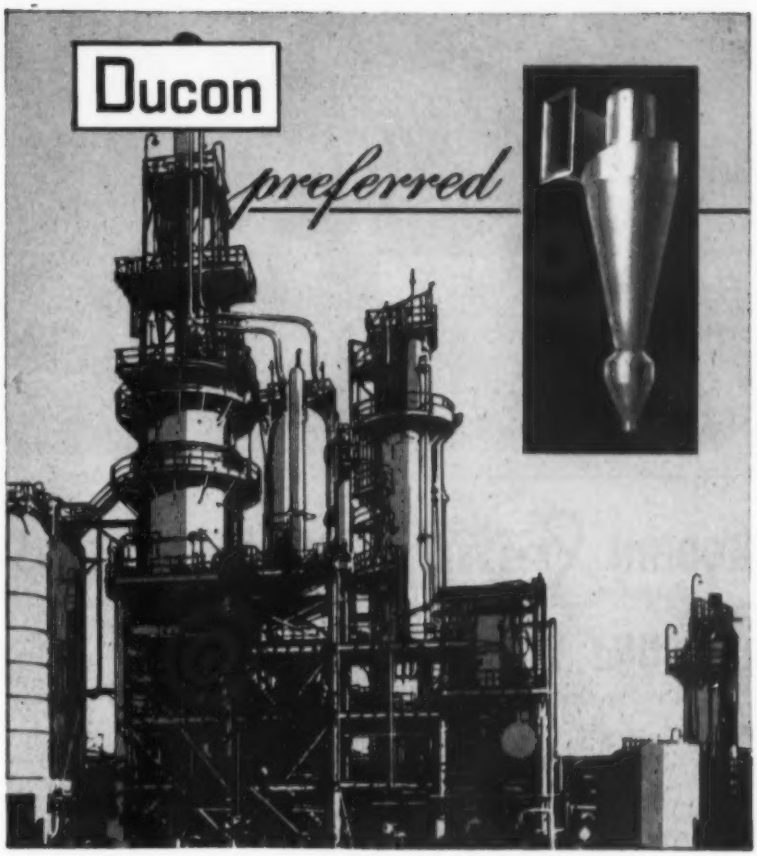
Fluor Backs Program To Train Draftsman

Fluor Foundation has announced the award of five $200 scholarships in piping drafting to junior college students in Southern California. The foundation is a non-profit corporation which distributes educational and charitable donations of the Fluor Corporation, Ltd.

Each scholarship pays $100 a semester for two semesters. An additional provision supplies the option of summer vacation employment preceding and following the scholarship year. Since 1953, when the program was initiated to stimulate interest in drafting as a career, 15 students have received the awards.

To Dedicate Laboratory

The new Parma, Ohio, research laboratories of National Carbon Company, a division of Union Carbide and Carbon Corporation, will be dedicated September 18. Designed primarily for basic research in chemical and solid state physics, the multi-million dollar laboratory brings to seven the number of major research centers operated by divisions of Union Carbide and Carbon Corporation. In 1955



. . . for Catalyst Recovery in
Leading Oil Refineries throughout the World

Ducon Type SDC Cyclones
are specifically designed for high
efficiency operation in petroleum refining
processes such as:

- Fluid Bed Catalytic Cracking
- Thermofor Catalytic Cracking
- Elutriator Towers
- Fluid Coking
- Fluid Hydroforming
- Catalyst Disposal and Conveying
- All Fluid Solid Operations

Full descriptive literature on request

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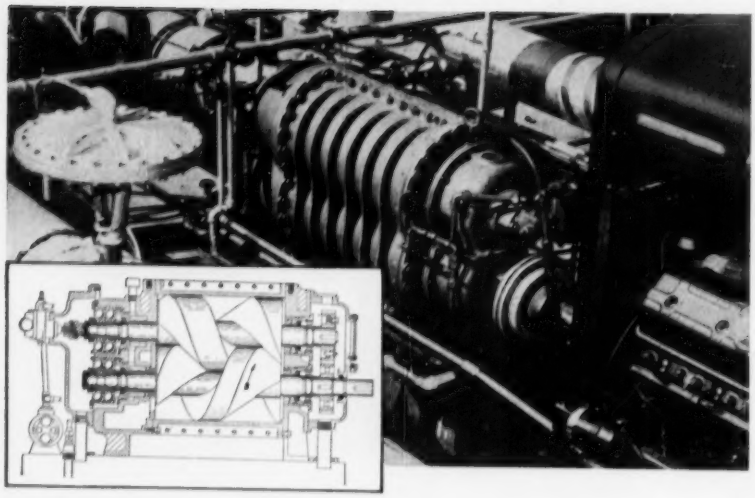
CYCLONES • CENTRIFUGAL WASH COLLECTORS • TUBULAR CLOTH FILTERS • DUST VALVES



MODERN SPIRAXIAL® COMPRESSORS

BUILT WITH R-C *plur-ability*

Users of these latest Roots-Connersville Spiraxial Compressors tell us of their amazing efficiency and economy, at ranges of 700 cfm to 5,000 cfm, and pressures from 15 psi to 30 psi (or higher).

Then, there are these other R-C *plur-ability* advantages:

- No internal lubrication, hence oil-free air
- Direct-connected for speeds of 1750 rpm and 3550 rpm
- No water jacketing needed
- Compact—requires less space
- Minimum noise level

With many applications possible because of these advantages, we suggest you study the performance curves and other details in Bulletin SC-354. You may well find that the long-time economy of R-C Spiraxial units will justify replacing less efficient equipment.

Ask about *plur-ability* in all R-C equipment

Centrifugal and Rotary Positive Blowers, Gas Pumps and Exhausters

•

Positive Displacement Vacuum Pumps and Meters

Inert Gas Generators

•

Spiraxial® Compressors

•

Detailed bulletins available on all R-C equipment.

ROOTS-CONNERSVILLE BLOWER

A DIVISION OF DRESSER INDUSTRIES, INC.

956 Crescent Ave., Connersville, Indiana. In Canada, 629 Adelaide St. W., Toronto, Ont.

What's Happening . . .

the corporation spent approximately $43 million on research. The new laboratory facilities at Parma already are in operation.

IRAA Offers Help In Case of Suez Crisis

Independent Refiners Association of America has offered "to cooperate with the government in every feasible way" in a Suez crisis.

This assurance of help was made to Hugh A. Stewart, director of the Interior Department's Office of Oil and Gas; it was made by M. H. Robineau, president of the association.

In a telegram to Stewart, Robineau stated that the association already is working on plans for industry and individual action to solve any petroleum problems growing out of the nationalization of the canal zone.

"Free Europe should not be allowed to suffer in the event of an emergency if America can come to its assistance," he said. "It can be assured that the American petroleum industry will do its part."

Stewart, in reply to the message, said he was "certain that in the future as in the past the independent refiners of this country will assist their government whenever requested."

Poly Unit Permits New Cosden Venture

Construction of a new polymerization plant at Big Spring, Texas, has made it possible for Cosden Petroleum Corporation to start commercial production of multi-viscosity polybutene.

Cosden has operated a small, semi-commercial pilot plant producing polybutene since the fall of 1953. The decision to erect a new plant using several new methods of operation was based on data and experience gained from the operation of this unit.

Basically, Cosden's continuous process uses a C_4 feed stream from which a heart cut of isobutene or isobutylene is fractionated. The polymerization catalyst employed is anhydrous aluminum trichloride. Resulting reactions take place at temperatures as low as —30 F to —40 F, depending on the desired viscosity of the product. Saybolt viscosities of 100 seconds/100 F to 20,000 seconds/210 F are contemplated.

Polybutene is a component in the manufacture of caulking and sealing compounds, pressure-sensitive adhesives and in vibration dampeners.

Stauffer Buys Two Affiliates

Stauffer Chemical Company has completed the purchase of two companies formerly owned jointly with Harshaw Chemical Company. The two companies are New York-Ohio Chemical Corporation and Nyotex Chemicals, Inc.

New York-Ohio Chemical Corporation, which manufactures anhydrous aluminum chloride, antimony trichloride, and anhydrous hydrogen chloride, was formed by

The risk is too great —clean it right

You don't take risks when men, equipment, and lost production time are involved. That's why more and more companies are investigating the methods and firms used in their chemical cleaning. They know it's work for experts.

What are they concerned about?

First, they want to know they are getting the benefits of experience. These benefits include less downtime and more thorough cleaning. Dowell has this experience with over 15 years and 10,000 boilers alone to their credit. In saving downtime, Dowell often cleans equipment while it is in operation.

Next, these companies want to be sure their men and equipment have the greatest possible protection. Dowell excels here, too. For safety is foremost in the Dowell engineer's mind. Thoroughly trained, he uses only the latest safety methods and equipment. He works closely with your safety personnel to establish safest possible working procedures.

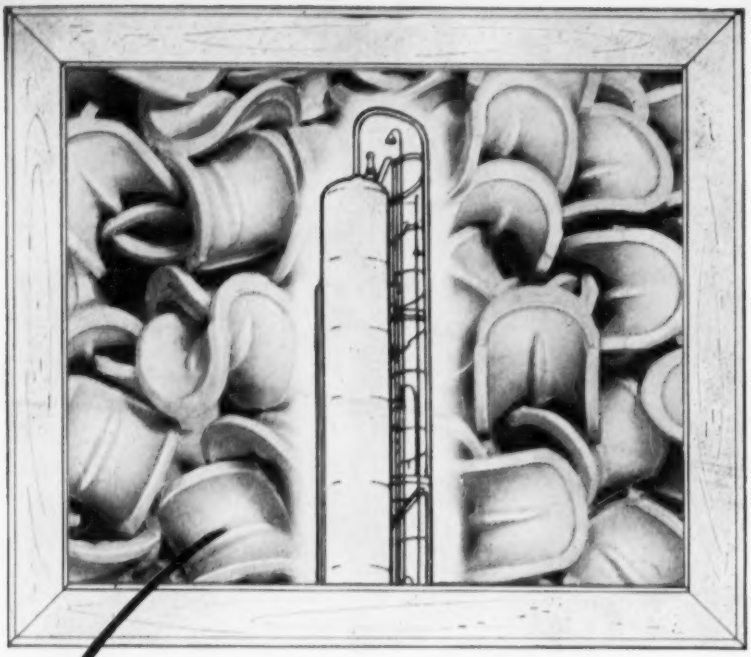
Be sure you are getting maximum results with maximum protection in your chemical cleaning.

Call the Dowell office near you. Dowell engineers are ready to discuss and help you with your cleaning problems any time, at no obligation. Or write Dowell Incorporated, Tulsa 1, Oklahoma, Dept. I-31.

chemical cleaning service for industry

DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY



When tower efficiency must be increased,

Berl Saddles

belong in the picture!

When the problem is how to increase tower efficiency in present or new equipment, that's when Berl Saddles enter the picture.

REASON:

Berl Saddles are a more efficient tower packing than raschig rings, spiral rings or partition rings. They offer greater surface area, lower resistance to gas flow, lower pressure drop, higher flow capacities, greater free space and better internal distribution. They are entirely acid proof, have a high crushing strength and will not spall.

Berl Saddles are available in both Knight-Ware Chemical Stoneware and porcelain. Both are dense but unglazed to provide better wetting. When desired porous packing can be made of either material.

Berl Saddles are available in sizes: ¼", ½", ¾", 1", 1½", 2".

Write for data sheet No. 13-G Knight-Ware Tower Packings.

Maurice A. Knight 956 Kelly Ave., Akron 6, Ohio

Acid and Alkali-proof Chemical Equipment

What's Happening . . .

Stauffer and Harshaw in 1941. It has plants in Elkton, Md.; Niagara Falls, N. Y. and Dominguez, Calif.

Nyotex Chemicals, Inc., which manufactures anhydrous aluminum chloride, anhydrous hydrogen fluoride, and lime products was formed jointly by Stauffer, Harshaw, and Consolidated Chemical Industries, Inc. in 1942. Consolidated Chemical was merged into Stauffer in 1955. The Nyotex plants are in Houston and Baton Rouge.

National Distillers Starts New School-Aid Program

National Distillers Products Corporation and its subsidiaries, including U. S. I. Chemicals Company Division and the part-owned National Petroc-Chemicals Corporation, has inaugurated a new type program of financial aid to education.

Under the program, National Distillers will match employe contributions to educational institutions. Any contribution of an employe to a U. S. secondary or preparatory school, college or university will be matched by the company to a limit of $1000 for any one employe.

The company's new comprehensive program also encompasses ten four-year scholarships at the college level, a donation equivalent to two scholarships to the National Fund or Medical Education and a number of graduate fellowships.

Wilcox Oil Closes Oklahoma Refinery

Wilcox Oil Company is closing its 5500-barrel-a-day refinery at Bristow, Okla. Company officials said the plant would be closed due to conditions brought on by the increasing demands for higher-octane gasoline. The refinery, which has been running about 4683 barrels a day, is equipped with a 2250-barrel-a-day thermal cracker, a 1700-barrel-a-day catalytic reformer and a 120-barrel-a-day polymerization unit.

Opinion Would Effect Los Angeles Refining

Companies planning new refining facilities in the Los Angeles basin will have to consider a recent opinion of the county attorney. According to that official, Los Angeles Air Pollution Control authorities have the power to keep out new industries which contribute to the area's smog problem. He also believes the county may prevent plants in operation from expanding. The opinion has not been tested in court.

New Chemical Complex

Agreements have been reached between four companies and a bank to create a new industrial chemical complex in southwest France, based on natural gas discovered not long ago at Lacq. The companies —l'Office National Industiel de l'Azote (Nitrogen), la Companie de Produits Chimiques et Electro-Metallurgiques Pechiney, la Manufacture de Glaces et Produits Chimiques de Saint-Gobain, Chauny et Cirey and Pierrefitte-Kalaa-Djerda—as well as Banque de Paris et des Pays-Bas will set up a corporation to carry out advance research and eventually to put up plants for chemical production.

"Fishing" for Better Quality? Prompt Delivery?

Specify Acipco Spun Steel Tubes

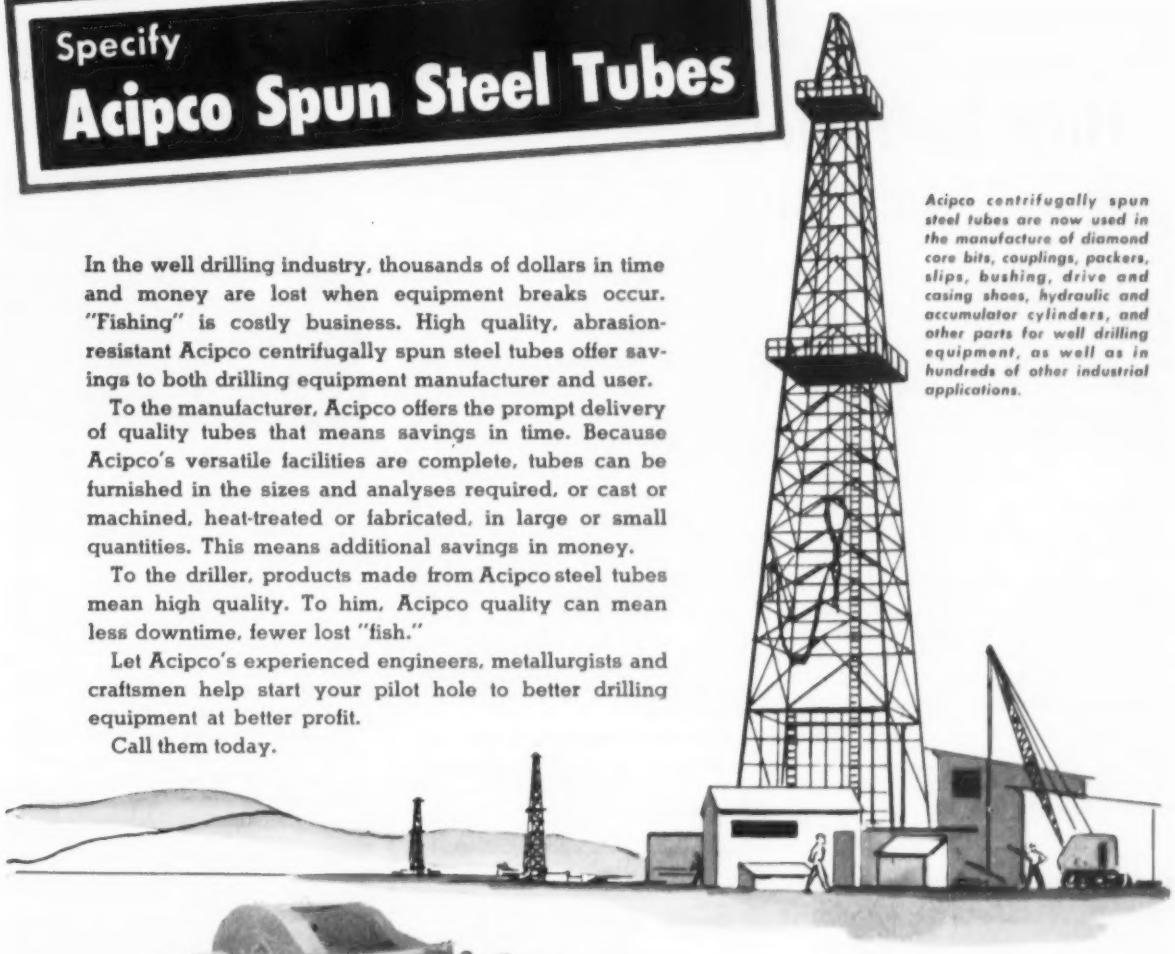
In the well drilling industry, thousands of dollars in time and money are lost when equipment breaks occur. "Fishing" is costly business. High quality, abrasion-resistant Acipco centrifugally spun steel tubes offer savings to both drilling equipment manufacturer and user.

To the manufacturer, Acipco offers the prompt delivery of quality tubes that means savings in time. Because Acipco's versatile facilities are complete, tubes can be furnished in the sizes and analyses required, or cast or machined, heat-treated or fabricated, in large or small quantities. This means additional savings in money.

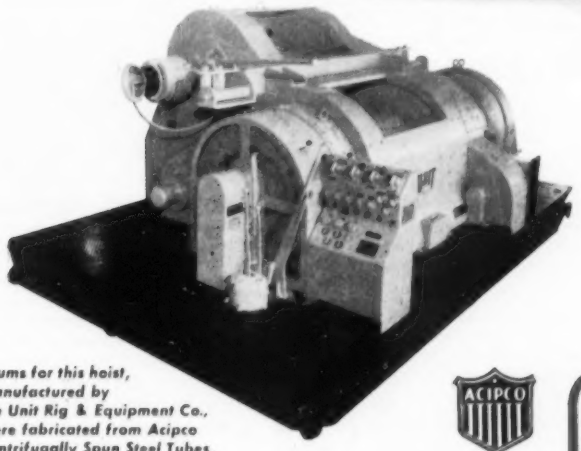
To the driller, products made from Acipco steel tubes mean high quality. To him, Acipco quality can mean less downtime, fewer lost "fish."

Let Acipco's experienced engineers, metallurgists and craftsmen help start your pilot hole to better drilling equipment at better profit.

Call them today.



Acipco centrifugally spun steel tubes are now used in the manufacture of diamond core bits, couplings, packers, slips, bushing, drive and casing shoes, hydraulic and accumulator cylinders, and other parts for well drilling equipment, as well as in hundreds of other industrial applications.



Drums for this hoist, manufactured by the Unit Rig & Equipment Co., were fabricated from Acipco Centrifugally Spun Steel Tubes.

SIZE RANGE: Lengths up to 16' — longer lengths by welding tubes together. OD's from 2.25" to 50"; wall thicknesses from .25" to 4".

ANALYSES: All alloy grades in steel and cast iron, including heat and corrosion resistant stainless steels; plain carbon grades and special non-standard analyses.

FURNISHED: As cast, rough machined, or finish machined, including honing.

AMERICAN CAST IRON PIPE CO.
Special Products Division
BIRMINGHAM 2, ALABAMA

DISTRIBUTORS:

Austin-Hastings Co., Inc.
226 Binney St.
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J. M. Tull Metal & Supply Co.
285 Marietta St., N. W.
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Peter A. Frasse and Co., Inc.
17 Grand St.
New York 13, N. Y.

C. A. Roberts Company
2401 Twenty-fifth Avenue
Franklin Park, Ill.

Lyman Tube & Bearings, Ltd.
920 Ste. Sophie Lane
Montreal 3, Canada

Strong, Carlisle & Hammond Co.
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Cleveland 13, Ohio

Ducommun Metals & Supply Co.
4890 So. Alameda St.
Los Angeles 54, Calif.

For more data on advertised products, use Readers' Service Cards, last page.

BRISTOL'S INSTRUMENTATION

News and information about automatic controlling, recording and telemetering

How instrument men pick a winner!

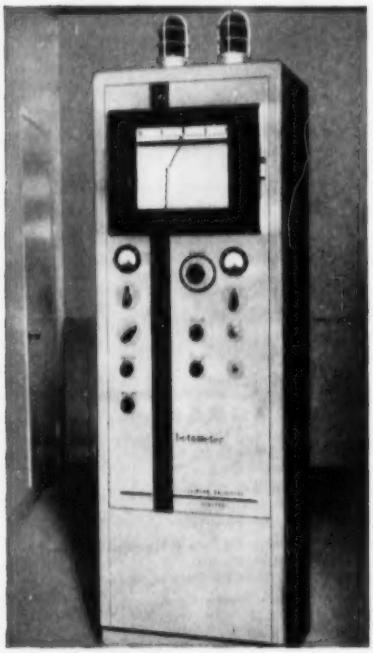
More and more manufacturers are incorporating Bristol's Electronic Dynamaster® potentiometer and precision all-purpose bridge instrument into their own instrument systems. On these pages you'll see a few of its applications—in the measurement, recording and control of any variable that can be translated into an electrical quantity. There are good reasons for this choice of the Dynamaster—whether for plant, laboratory or pilot plant application. Here they are:

1. Continuous standardization eliminates need for dry cells and standardizing mechanism—result: no interruption to control, no dry cells to replace.
2. High accuracy . . . fast operation . . . continuous electronic measurement.
3. Simple in design . . . few moving parts.
4. Easy to use and service . . . little or no maintenance required.
5. Flexible in application.
6. Rugged in construction . . . unaffected by vibration.
7. Plant operating men quickly become familiar with this instrument and like to use it.
8. Versatile for single-pen, two-pen, and multiple record (up to 24 points), with either strip- or round-chart.

ELECTRONIC AND PNEUMATIC CONTROLLERS. Both strip- and round-chart instruments are made in a very wide variety of controllers that meet every control requirement, including:

Electric Control—on-off, proportional input, 3-position, proportioning, proportional with automatic reset, and time-program.

Pneumatic Control—high-gain (on-off), proportional, proportional with reset, and proportional with reset and derivative.



Gauges sheets to 0.25 lb. in 3000 sq. ft.

The "Betameter," one of the latest results of modern nuclear instrumentation, was designed and built by Isotope Products of Buffalo, New York, and Oakville, Ontario. It can measure thickness of all continuous sheet materials from tissue paper to 0.070-inch steel. It attains accuracies up to 0.25 pound of material per 3000 square feet.

Beta rays, beamed through the material to be measured, cause electric current flow in a detector. The current, proportional to deviation of the material from the desired thickness, is amplified and recorded, or used for automatic control, by a precision Bristol Dynamaster instrument.

Dynamasters are also used in Isotope Product's "Gammagage" (for measuring heavier materials), "Profiler" (for taking the profile of strip samples), and "Betacoater" (for gauging thickness of coatings).

ISOTOPE PRODUCT'S "Betameter."
(Advertisement)

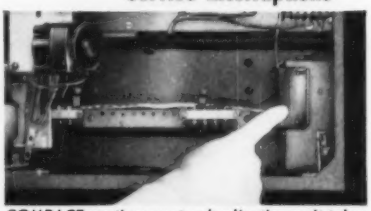
Punched-card cement batcher increases accuracy

This novel automation system, installed at Cleveland Builders Supply Corporation's Cleveland, Ohio, plant, was designed to turn out twice as much ready-mixed concrete as the company's similar conventional plants.

The operator merely drops a card, punched with the mixing formula, into the machine and the mixture is ready in a matter of seconds. Ingredients are accurate to 2 pounds as against 25 for a human operator. This results in considerable savings in material and also reduces operator fatigue.

Essential part of the installation are the Bristol Dynamaster recorders that provide permanent records of the output of strain gauges used in the weighing process.

How "No-Batt" bans service interruptions



COMPACT continuous standardization unit takes place of dry cell in this Dynamaster recorder.

All the convenience of a line-operated power supply plus the accuracy and stability of a standard cell—that's what Bristol's "No-Batt" continuous standardization gives the user. There are no dry cells to replace and absolutely no interruptions to service for standardization.

This ingenious development achieves voltage accuracy of 1/10th of 1 per cent with an estimated standard cell life of 5 to 7 years.

All Dynamaster models may be equipped with this feature for completely uninterrupted recording, measurement or control—and, of course, the more conventional dry-cell and push-button or automatic standardization are still available.

For more data on advertised products, use Readers' Service Cards, last page.

NEWS AND NOTES

instruments from Bristol . . . leaders in human-engineered instrumentation

Greatest analytical development in decade!

Gas chromatography units, with Bristol recorders, speed analysis

Computing and recording equipment is now aiding automatic qualitative and quantitative analysis of gases and volatile liquids by partition chromatography. Scientists at Gulf Research and Development Co., and Fisher Scientific have built an instrument using a thermostatted chromatographic column to resolve components of each mixture.

As each component emerges from the column, it is detected and a record made on a built-in, accurate high-speed Dynamaster recorder. An automatic integrator simultaneously computes the quantity of component and makes a second record.

Other units which use Dynamaster recorders in this application include Podbielniak's *Chromacon*, Beckman's *Gas Chromatograph*, and Research Equipment Corp.'s *Distillograph*.

Photo courtesy of Fisher Scientific Company.

Professors turn students at Bristol

Education for automation started at Bristol back in 1920 with an instrumentation school for our own sales and service engineers. In 1927, we invited our customers' engineers to our school—and in 1949, we opened our first free summer training session (since repeated several times) for professors from engineering schools throughout the country.

Among subjects studied: pressure and vacuum, including liquid level and absolute pressure; telemetering; flow measurements; pyrometers, thermocouples and resistance thermometers; electronic detection; filled thermometer systems and relative humidity; and electrical measurements with voltmeters, ammeters and wattmeters.

Oxygen Analyzer uses Dynamaster recorder

Recording and control of oxygen in gases of all types is the job of this oxygen analyzer, designed and built by Arnold O. Beckman, Inc., South Pasadena, Cal.

The operating principle of the instrument depends only on the paramagnetic properties of oxygen. No combustion, hot wire or consumption of the sample is involved. This precision analyzer uses the meticulously designed and manufactured Bristol Dynamaster recorder to indicate and record its measurements of oxygen content.

Dynamaster component takes to air

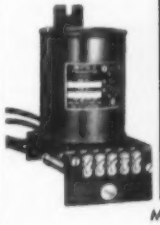
Official U. S. Air Force photo.

Flying high now, as a vital part in military aircraft like that shown above, Bristol's Syncroverter® switch got its start in the Dynamaster potentiometer.

Originally designed to help the Dynamaster endure extremes of shock and vibration (in steel rolling mills and the like), the Syncroverter switch or "chopper" is used now in aircraft to convert d-c signals to corresponding a-c signals, making possible use of highly stable a-c amplifiers.

The Syncroverter switch, noted in aircraft instruments and missile systems for its trouble-free life of thousands of hours, is one of the building blocks that make Bristol's Dynamaster the rugged instrument it is.

SYNCROVERTER switch for instruments.



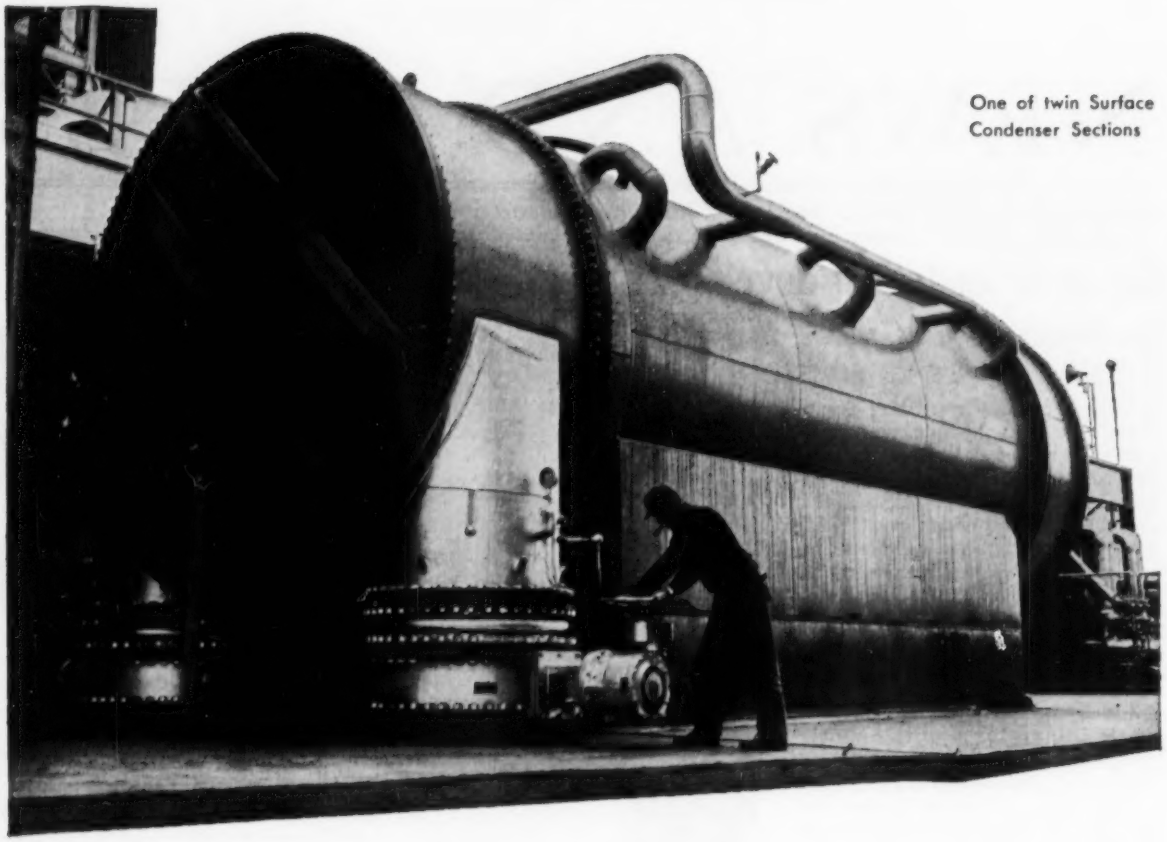
MINIATURE SYNCROVERTER switch for aircraft.

Technical data available

We'll send you complete technical data on Dynamaster potentiometer and bridge instruments for measurement, recording or control. Or our engineers will be glad to discuss your specific application problems with you. Write today to The Bristol Company, 111 Bristol Road, Waterbury 20, Conn. 629

WHAT'S NEWS AT BRISTOL . . . WHAT'S NEWS AT BRISTOL . . .

For more data on advertised products, use Readers' Service Cards, last page.



One of twin Surface Condenser Sections

Lummus Equipment Serves 110,000 KW Turbine For Texas Power and Light Company

Approximately 1 year ago, Lummus completed the installation of a 34,000 lb. per hr. evaporator, a 90,000 sq. ft. surface condenser and five feed water heaters, to serve a 110,000 KW turbine generator at the Collin Steam Electric Station of the Texas Power and Light Company.

The evaporator, designed by Lummus, is a high purity type which produces vapor of 1 ppm max. total solids purity, with a shell concentration of 3,000 ppm. It was furnished complete with a Lummus reflux condenser for producing condensate to be used on the bubble tray.

The Lummus-designed surface condenser is in two sections, joined by a common tee piece which connects to the turbine exhaust. The condenser is of the deaerating type producing an oxygen guarantee of 0.01 cc per liter.

The following Lummus feedwater heaters were furnished:

Item	Operating Pressure	Eff. Sq. Ft. Surface
Crossover Heater (Multilok)	2600#	6,745 sq. ft.
High Pressure Heater (Multilok)	2600#	6,490 sq. ft.
Intermediate High Pressure Heater	400#	2,850 sq. ft.
Intermediate Low Pressure Heater	400#	3,165 sq. ft.
Low Pressure Heater	400#	4,610 sq. ft.

Lummus heat transfer equipment provides long and trouble-free service in power generation.

THE LUMMUS COMPANY, Heat Exchanger Division, 385 Madison Avenue, New York 17, N. Y.
Atlanta • Boston • Chicago • Cincinnati
Cleveland • Dallas • Denver • Detroit • East Chicago (Indiana) • Houston • Kalamazoo
Kansas City • Los Angeles • Minneapolis
Nashville • New Orleans • Newton (Iowa)
Niskayuna (New York) • Omaha • Pittsburgh
Salt Lake City • San Francisco • Springfield (Mass.) • Syracuse • Toledo • Wayne (Pa.)
Athens • Buenos Aires • Caracas • The Hague
Lima • London • Mexico City • Montreal • Paris
Rome • San Juan

Steam Surface Condensers • Evaporators • Extraction Bleeder Heaters • Steam Jet Air Ejectors • Steam Jet Refrigeration • Barometric Condensers • Heat Exchangers for Process and Industrial Use • Process Condensers • Pipe Line Coolers

Fabricated Piping Division Plant at East Chicago, Ind.

LUMMUS

HEAT EXCHANGER DIVISION

For more data on advertised products, use Readers' Service Cards, last page.

What's Happening . . .

. . . *Among Men* in the Industry

Thompson McDaniel Knepp

George R. Thompson heads a list of three major personnel changes in the Manufacturing department of The Standard Oil Company (Ohio). Formerly general superintendent of the No. 1 Refinery in Cleveland, he has been transferred to Toledo where he will be general superintendent of the refinery there. **Kenneth A. McDaniel**, general superintendent of the Toledo refinery, will replace Thompson as general superintendent of the Cleveland plant. And **George C. Knepp**, chief process engineer at the Lima refinery, was promoted to the newly-created position of project coordinator at Toledo.

Francis G. Hester has been named maintenance and engineering superintendent of Great Northern Oil Company's Pine Bend, Minn., refinery. Hester, who has been with Great Northern since early 1955, previously served as chief engineer and assistant maintenance superintendent. He spent four years as chief engineer and maintenance superintendent for Great Southern Chemical Corporation at Corpus Christi, Texas, before going to Minnesota.

Carl C. Georgian has been made group leader in the Technical Service division of the Research and Development department at American Oil Company's Texas City refinery. Georgian joined the company in 1952, and was assigned to the Research and Development department's Process Development section. In 1955, he was transferred to the Technical Service section where he has been assigned since.

Duncan Neblett, general counsel for Eastern States Petroleum Company, has been elected vice president. Neblett joined the company in 1943 as an attorney. He later was promoted to vice president and director, but left the company in 1947 to enter private law practice. He rejoined Eastern States in 1951.

Frank R. Mayo has joined Stanford Research Institute as a senior research chemist and member of the Fundamental Research group in the Physical Science division. Dr. Mayo was with General Electric Company in its research laboratories at Schenectady, N. Y., where for several years he worked in the oxidation of unsaturated compounds.

W. D. Allison has been promoted to supervising engineer in the Engineering division of Humble Oil & Refining Company's Baytown, Texas, refinery. Also receiving a new assignment in the Engineering division was **M. L. Crow**, named senior mechanical engineer. And in the Coordination division **V. B. Brown** and **P. L. Nevil** were advanced to senior coordination engineers.

Reese H. Taylor has been elected chairman of the board of Union Oil Company of California. He will remain as chief executive officer of the company. **W. L. Stewart, Jr.**, formerly senior vice president, was made vice chairman of the board, and **A. C. Rubel**, formerly a vice president, was elected president.

Taylor had been president of the company since 1938, as well as a director and member of the executive committee. Both Stewart and Rubel are directors and members of the executive committee. **F. L. Hartley**, director of research, was elected vice president.

Elected as a member of the board was **Frank R. Denton**, vice chairman of the board of Pittsburgh's Mellon National Bank and Trust Company. He replaces **George M. Wallace**, who recently died.

Anderson Bowerman

J. A. Anderson, Jr., has been promoted to research associate, and E. W. Bowerman, to assistant division head in the Research and Development division at Humble Oil & Refining Company's Baytown refinery.

John W. Towler, manager of the Los Angeles refinery of Union Oil Company of California, has been named to a newly-created position of director of manufacturing. **W. T. Jameson**, assistant manager of the Los Angeles refinery, will become manager.

Towler, after returning from service in the Air Force during World War II, served as chief engineer at the Los Angeles refinery until 1953 when he was appointed manager of Union's Oleum, Calif., refinery. He became manager of the Los Angeles refinery in June 1956. Jameson was manager of Union's Santa Maria, Calif., refinery before he was assigned to the Los Angeles plant earlier this year.

Thomson Hartman Chapman

Stuart W. Thomson has been named assistant manager of the Paulsboro, N. J., refinery of Socony Mobil Oil Company, Inc., effective July 1. Also named are **R. C. Hartman** as assistant to the manager and **H. D. Chapman** as operating superintendent. **E. D. Keiper** was named assistant superintendent of the lube-wax division and **Elmer L. Smith** was appointed assistant superintendent of the light products division.

H. W. Grote will direct the activities of a new department organized by Universal Oil Products Company for the commercial application of petrochemical processes licensed by the company. The new department will function under the overall direction of **M. D. Gilchrist**, process sales vice president. Grote was formerly assistant manager of the company's research and development laboratories.

At the same time, **E. R. Kanhofer**, formerly manager of Universal's facilities at Riverside, Ill., has been named assistant to **Col. J. C. Raaen**, vice president in charge of research.

George H. Freyermuth has been elected chairman of Esso Export, Ltd., and Standard Oil International, Ltd., with headquarters in London. With the Standard Oil Company (New Jersey) organization 28 years, he has been executive vice president of Esso Export since 1954.

B. R. Dorsey has been appointed coordinator in Gulf Oil Corporation's Manufacturing department. Formerly supervisor of scheduling and cost control for the department, he succeeds the late **E. J. Kirberg**. He started with the company in 1940 at Port Arthur.

Jack Maloney has been appointed petroleum technical service advisor for the Chemical division of Armour and Company in Chicago. Maloney started with the company six years ago.

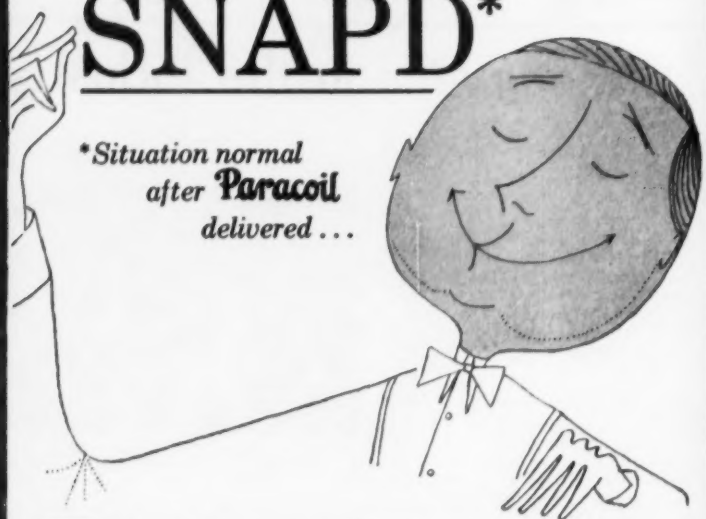
John W. Gendron of Tidewater Oil Company has been elected president of Iricon Agency, Ltd., succeeding **R. S. Stewart**, vice president of The Standard Oil Company (Ohio).

Iricon is the organization established to represent the five percent interest in

For more data on advertised products, use Readers' Service Cards, last page.

SNAPD*

*Situation normal after **Paracoil** delivered . . .*



The *new* major source for OIL & WATER COOLERS

The new Paracoil Oil and Water Coolers—Type "P" Exchangers—are solving production problems throughout industry. In addition to prompt delivery, users are finding these advantages:

- Tube bundles removable without removing connected piping. Only one set of bolts need be backed off
- Built with standard components
- Straight tubes for ease in cleaning
- Wide selection of materials
- Standard commercial, ASME or Marine Code construction
- Close baffle tolerances for maximum heat transfer
- Easy access to both ends of tubes for inspection, test or cleaning
- Double-packed floating tube sheet
- Tell-tale holes in packing ring to indicate gland leakage
- Provision for zinc anodes

USES:

Oil Coolers — for bearing, turbine, hydraulic systems, transformer, gear oil systems.

Air or Gas Coolers — for inter-and after-coolers on air compressor installations and miscellaneous gas cooling applications.

Water Coolers — for internal combustion engine and compressor jacket water, electrolyte solutions, brine solutions, boiler blow-down, condensate, etc.

For stationary and marine service

Type "PC" 2-Pass Turbine Oil Cooler
Double Packed Tube Sheet • Channel Design

Davis Makes it! BETTER

DAVIS ENGINEERING CORPORATION
30 Rockefeller Plaza, New York 20, New York
1064 East Grand Street • Elizabeth 4, New Jersey

Men in the Industry . . .

the Iranian Consortium held by American Independent Oil Company, Atlantic Refining Company, Getty Oil Company, Hancock Oil Company, Richfield Oil Corporation, San Jacinto Petroleum Corporation and Signal Oil and Gas Company, as well as Standard of Ohio and Tidewater.

Stewart now assumes a vice presidency of the agency after serving as its first president under an Iricon policy of rotating executive posts among officials of member companies. Gendron continues as manager of Tidewater's Oil Purchase and Exchange department in addition to his responsibilities with Iricon.

Other newly-elected officers include **L. C. Bergquist** of Iricon's London office, vice president; **David E. Day** of Richfield, vice president; **J. J. Shrewsbury** of Hancock, treasurer; **S. K. McCauley** of Atlantic, assistant treasurer, and **Raymond W. Ickes** of American Independent Oil Company, assistant secretary.

Benjamin Tyran of American Independent and **John K. Schemmer** of San Jacinto were elected to the Iricon board of directors.

Leslie G. Boatright has joined Escambia Bay Chemical Corporation in its New York offices, where he will devote full time to the Commercial Development department. Dr. Boatright joins Escambia Bay from Jefferson Chemical Company where he was manager of market development with offices in Houston. Prior to this he was a research chemist with American Cyanamid Company in its Stamford research laboratory.

Harry A. Jackson, formerly with Tidewater Oil Company, has been elected president of the new American Petrofina, Inc. Connected with the petroleum industry more than 35 years, Jackson was vice president and general manager of Tidewater's Eastern operations. American Petrofina is an affiliate of Compagnie Financiere Belge des Petroles, S. A.

H. P. Arbuckle and **P. Superty, Jr.,** have been elected assistant comptrollers of Gulf Oil Corporation. Both are veteran employes with long experience in the company's accounting and auditing operations.

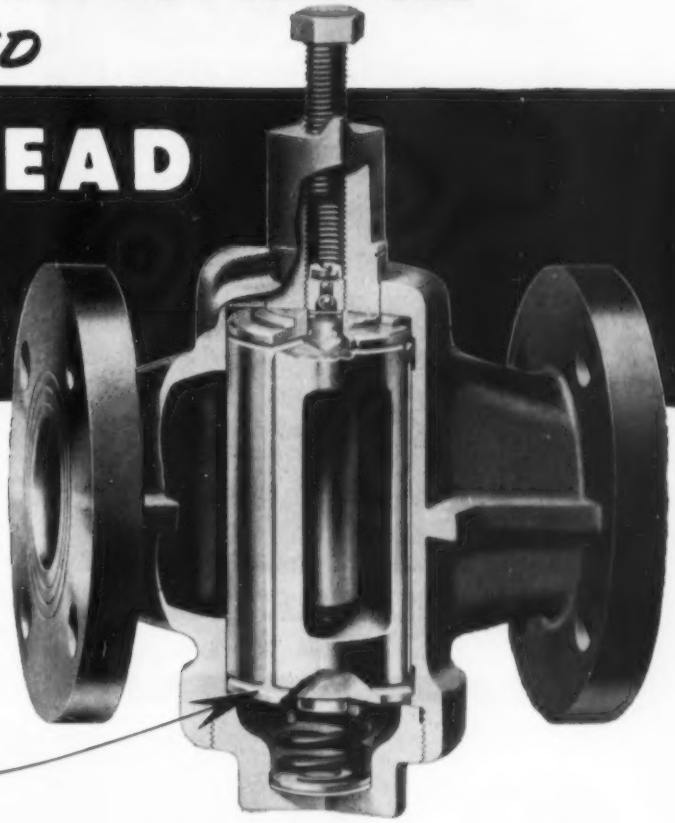
Frank J. Fontana, chief engineer in the Refining division of Richfield Oil Corporation, has been elected chairman of the Southern California Section of The Society of Mechanical Engineers.

W. J. Anderson has joined Standard Oil Company of California as head engineer in the Project division of the General Engineering department. Formerly with Commonwealth Oil Refining Company, he had served that company as an executive assistant and before that was process superintendent at Commonwealth's new Puerto Rican refinery. He also has been with Standard Oil Company (Indiana) as process general foreman at the Standard refinery at Sugar Creek, Mo.

J. H. Forrester has been elected president of Indoil Chemical Company, a subsidiary of Standard Oil Company (Indiana). He will succeed **William B. Plummer** who is retiring to become a private consultant in the petrochemical field. Plummer will headquarter in New York. As

For more data on advertised products, use Readers' Service Cards, last page.

No. 5* of 12 REASONS WHY
YOU SHOULD BUY AND USE
LOW-PRICED
HOMESTEAD
Lubricated
PLUG VALVES



*SELF-FREEING PLUG PREVENTS STICKING

Homestead's exclusive completely controlled lubricant system positively prevents sticking by its instant, piston-like movement of the plug downward at the start of each lubrication. Spring and line pressure return it to stem-sealed position.

This is only **one reason why you should buy and use low-priced** HOMESTEAD LUBRICATED PLUG VALVES.

HERE ARE ALL TWELVE

1. Extra long valve life assured by very close tolerance between sealing surfaces.
2. Straight line fluid flow—streamlined ports—minimum resistance to flow—minimum pressure drop.
3. Triple head seal—two lubricant rings and reinforced Teflon stem seal prevent leakage.
4. Easy turning—plug floated on Teflon washer and reinforced Teflon ring.
5. Self-freeing plug prevents sticking.
6. Full-threaded screw prevents dirt being forced into lubricant system.
7. Quarter-turn fully opens or closes.
8. Reinforced Teflon stem seal—no cold flow—continuous, positive seal.
9. Seating surfaces protected in both open and closed positions.
10. High pressure lubricant system provides full lubricant seal around ports.
11. Leak-proof double ball and lubricant sealed check valve. No springs. No maintenance.
12. Two lubricants handle most services.

FOR CATALOG AND COMPLETE DETAILS MAIL COUPON TODAY

HOMESTEAD
VALVE MANUFACTURING COMPANY
"Serving Since 1892"
P. O. Box 45 **Coraopolis, Pa.**

Without obligation, send Reference Book 39—Section 5 on HOMESTEAD LUBRICATED PLUG VALVES.

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____

For more data on advertised products, use Readers' Service Cards, last page.

F.D.I.

COMPLETE DATA SHEET FILE ON

PRESSURE SYSTEM PROTECTION WITH FRANGIBLE DISCS

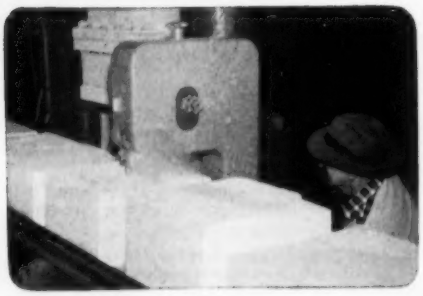
With more than 25 years' experience in applying known scientific principles to pressure protection together with carefully supervised experimental work, our engineers have acquired a wealth of highly specialized knowledge in the field of metal behavior.

We offer this information to you as a continuing data sheet file. It's free! Write for it today!

FRANGIBLE DISCS, INC.
PENNS GROVE, N. J.

FRICK

Compressors Make Dry Ice With New Economy



The Colorado CO_2 Corp. produces up to 50 tons of solid carbon dioxide daily in its $2½-million plant near Las Animas, Colo.

The gas, obtained from wells 5 miles away, is condensed, subcooled, and solidified at 109 degrees below zero F. with a new Frick-engineered cycle operating at very economical pressures.

Practically all the mechanical equipment in the plant was furnished and installed by Frick Company. Another example of the COMPLETE engineering service that is yours when you purchase Frick air conditioning, ice making, quick freezing or other refrigerating equipment. Let us quote you now on your requirements.

DEPENDABLE REFRIGERATION SINCE 1882
FRICK CO.
WAYNESBORO PENNA U.S.A.

Frick Equipment at Colorado CO_2 Corp.

Men in the Industry . . .

previously announced, Forrester will head the new consolidated company which is due to take over Indoil and two other Standard (Indiana) chemical subsidiaries later this year. Plummer has been with the Standard organization 26 years.

Charles A. Perlitz, Jr., has been promoted from senior vice president to executive vice president of Continental Oil Company. Named as senior vice presidents were **Harold G. Osborn** and **A. W. Tarkington.** Both were vice presidents, and Osborn was in charge of manufacturing.

R. L. Bosworth, who was treasurer, has been elected vice president and coordinator of company activities at Ponca City, while **L. C. Peters,** financial vice president, has been selected to take on the additional responsibilities of treasurer.

Harold M. Romig plans to enter private practice as a consulting engineer in Chicago, following his recent retirement from Standard Oil Company (Indiana). With the company 28 years, Romig was chief engineer in the General Engineering department's Process Engineering division when he retired.

kobert Gillespie, managing director of B. P. Tanker Company since 1950, has been named managing director of the parent British Petroleum Company. He succeeds **E. H. O. Elkington,** who retired.

Carl D. Thomas has been appointed supervisor of the Maintenance Engineering section of Pittsburgh Coke and Chemical Company's Chemical division. Thomas formerly was with Creole Petroleum Corporation at its Amuay Bay refinery in Venezuela, and from 1953 to 1955 he was in charge of planning, methods and statistics for the refinery's Maintenance and Construction group. He also has held engineering positions with Mid-Continent Petroleum Corporation, and at one time was a design engineer at its West Tulsa refinery.

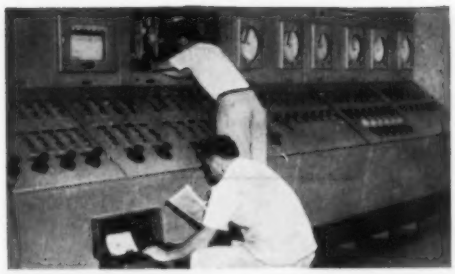
Walter J. Harrison has been named assistant supervisor of employe relations at the new Tidewater Oil Company refinery under construction near Wilmington. Harrison joined the company at Bayonne in 1952. He was transferred to the New York office earlier this year.

Ralph D. Beck has been appointed civil engineer at General Petroleum Corporation's Torrance, Calif., refinery. He replaces **L. E. Battelle,** who retired. Beck has been with the refinery since 1953 and held positions of draftsman-supervisor and assistant civil engineer. He has been with General Petroleum since 1942.

John A. Handy, Jr., has been elected vice president of finance and controller of Chemical Construction Corporation. Since 1952, Handy has been secretary of Jos. E. Seagrams & Sons, Inc., and prior to that was controller of Deering Milliken & Company. Previously, he was associated with the Carborundum Company.

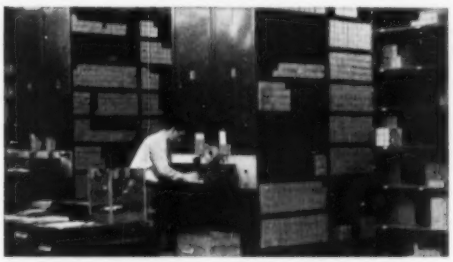
Edward A. Gize and **Charles T. Pease,** both process engineers, have been added to the staff of Procon, Inc. Gize was formerly with the Sinclair Refining

For more data on advertised products, use Readers' Service Cards, last page.



Maintenance engineering

You can arrange to have a Honeywell service engineer visit your plant at regular intervals to inspect, clean, and adjust your instruments and controls. He's factory-trained and field-experienced in keeping good instruments in top operating condition. If an emergency should arise, a phone call will bring a Honeywell service engineer to your plant in a hurry.



Spare parts, in a rush

A Honeywell branch office near you can be your storeroom for standard parts . . . in addition, the Parts Depot in Philadelphia carries a complete stock of all normally needed parts. With Honeywell stocking your spare parts, you save storage and inventory control costs. Most shipments are made within 24 hours after orders are received.

Application engineering

Experienced Honeywell application engineers know your industry and processes. They design *complete* systems of instrumentation, reducing the work of your own engineering staff. From the broad Honeywell line, they recommend instruments that are exactly right for the job. And because Honeywell supplies all types of instruments, recommendations are made without bias. Service engineers will, if needed, help with installation and startup of your system.

Service is the big extra you get with Honeywell instrumentation

Practical service training

The tuition-free Honeywell Training School teaches your instrument technicians the most up-to-date maintenance methods, fits them for the kind of problems they may encounter on the job. Intensive courses range from two to fourteen weeks.

Honeywell offers you far more than instruments. You get service whenever and wherever you need it . . . service that begins when you first decide you need instruments, and continues long after they're installed. This service is always conveniently close at hand, for there are more than 110 Honeywell sales and service centers located strategically throughout the U. S. and Canada.

Prompt, competent service by nearby field specialists is an important plus-value of Honeywell instrumentation. Your local Honeywell sales engineer has all the facts on this service as it relates to your instrumentation needs. Give him a call . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls

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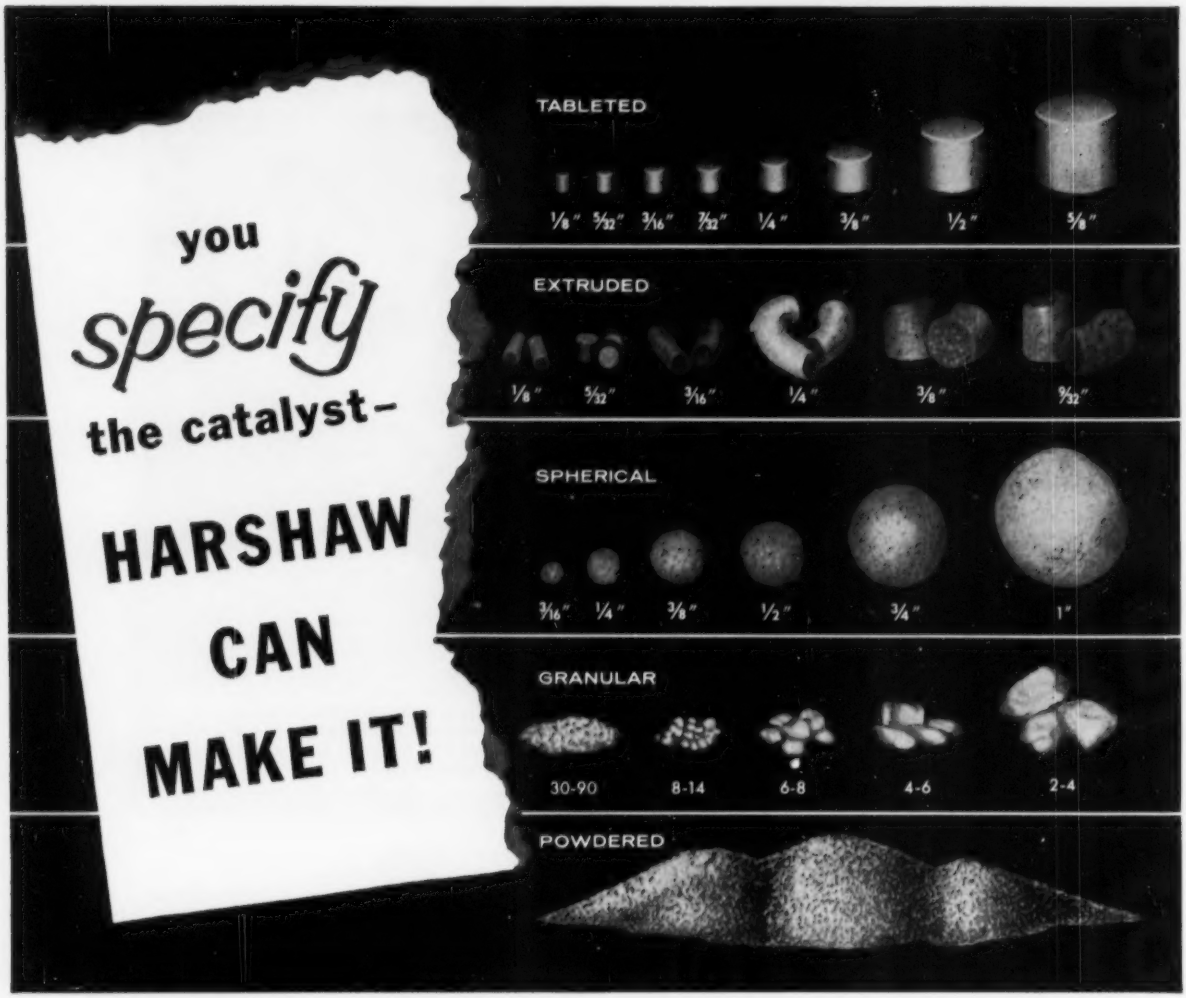

HARSHAW

has the facilities for producing carload quantities of

PREFORMED CATALYSTS

to fit special process requirements

Hydroforming	Dehydration
Cyclization	Desulphurization
Oxidation	Alkylation
Dehydrogenation	Isomerization
Hydrogenation	

CATALYTIC CHEMICALS SUPPLIED BY HARSHAW

Aluminum Nitrate		Cobalt Nitrate
Copper Nitrate		Manganese Nitrate Solution
Metallic Soaps (Cobalt, Manganese)		
Nickel Carbonate	Nickel Formate	Nickel Nitrate
Nickel Sulfate	Sodium Methoxide	Zinc Nitrate

Our experienced technical staff will assist you in developing the best and most economical catalyst. If you have a catalytic process in the development or production stage, a discussion with us may prove beneficial.

Write for FREE Booklet, "HARSHAW CATALYSTS"

HARSHAW

THE HARSHAW CHEMICAL CO.

1945 EAST 97th STREET • CLEVELAND 6, OHIO

Chicago • Cincinnati • Cleveland • Hastings-On-Hudson, N.Y. • Houston • Los Angeles
Detroit • Philadelphia • Pittsburgh

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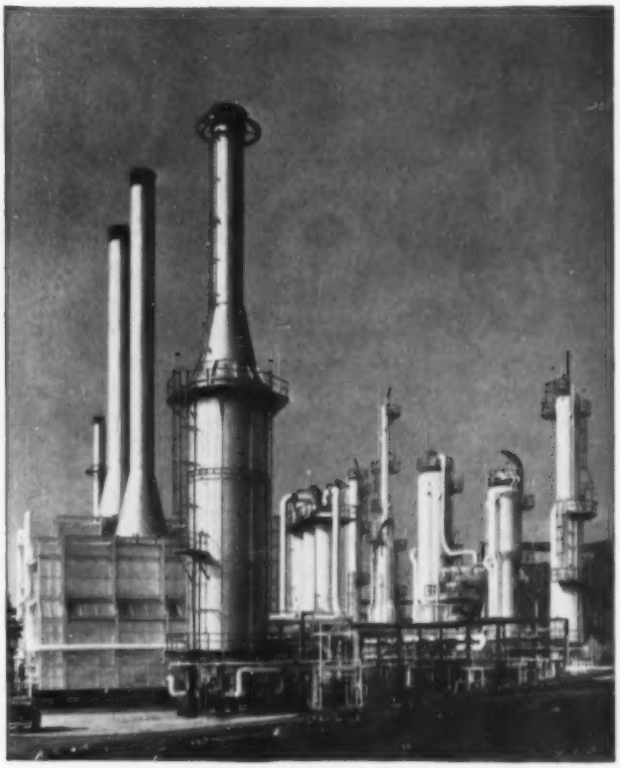
INTERESTED IN UNIFINING* FOR DESULFURIZATION AND UPGRADING



• Unifining Unit
Union Oil Company of California refinery
Oleum, California

UNIFINING should be of particular interest to all operators of catalytic reformers which produce by-product hydrogen.

• Harshaw is the exclusive producer of the Union Oil Company of California cobalt-molybdate catalyst used in the recently announced "Unifining" desulfurization and upgrading process. This rugged, commercially proven catalyst is supplied in the form of cylindrical tablets conforming to rigid physical and chemical specifications established by Harshaw and Union Oil Company of California. Stability at high temperatures permits repeated regenerations if and when necessary.

Please contact Harshaw for further information on this catalyst.

HARSHAW

THE HARSHAW CHEMICAL CO.

1945 East 97th Street, Cleveland 6, Ohio

Chicago 32, Illinois • Cincinnati 13, Ohio • Detroit 28, Michigan • Hastings-On-Hudson 6, N. Y.
Houston 11, Texas • Los Angeles 22, California • Philadelphia 48, Pennsylvania
Pittsburgh 22, Pennsylvania

* Trademark of Union Oil Company of California

For more data on advertised products, use Readers' Service Cards, last page.

It will guard your investment with its life. Outlasting ordinary pumps many times, NAGLE PUMPS are designed and constructed to withstand abusive service, such as pumping highly abrasive mixtures, corrosive liquids, hot solutions or heavy slurries. Horizontal and vertical shaft types in complete range of sizes.

Type "SW-O" shown, is directly submerged in material to be pumped. Free of packing and bearing troubles. Rendering outstanding service in important processing plants, mines and mills. Get the facts—ask for Bulletin SWO.

NAGLE PUMPS

NAGLE PUMPS, INC.
1251 CENTER AVE., CHICAGO HEIGHTS, ILL.

PUMPS FOR ABRASIVE AND CORROSIVE APPLICATIONS

IMPROVED PANAPAK TOWER PACKING

REDUCED COST

LOWER H.E.T.P. AT PARTIAL LOADING

HIGH CAPACITY

Additional information and Bulletin available on request

PACKED COLUMN CORP.

PACKED COLUMN CORPORATION
30 Church Street, New York 7, N. Y.

Men in the Industry . . .

Company as a technical field man on inspection and operating assignments. Pease came to Procon from the Arkansas-Louisiana Gas Company, where he was a process engineer in the natural gasoline division.

Tielrooy

Ray

Jack Tielrooy and **Robert S. Ray,** both recently named vice presidents of Brea Chemicals, Inc., have been elected to the board of directors and the executive committee. The company is a subsidiary of Union Oil Company of California.

Tielrooy will continue as Brea's manager of development with offices at the company's manufacturing facilities near Brea, Cal.

A graduate of California Institute of Technology, Tielrooy joined Brea when the company was formed in 1952. He had been in the Union Oil Company engineering department since 1948 and prior to that was with Shell Chemical Corporation.

As manager of development, he has played a major part in designing and supervising the construction of the company's ammonia, carbon dioxide, nitric acid, ammonium nitrate and other plant and warehouse facilities.

Ray has been manager of manufacturing for Brea, starting in 1953 when the company's first plants were under construction. He will continue in this capacity, with offices at Brea. He has charge of all the company's manufacturing operations.

Prior to joining Brea, Ray was associated with Shell Chemical Corporation for ten years and with Pan-American Refining before that. He graduated from California Institute of Technology where he received a masters degree in chemical engineering in 1941.

Charles A. Slikas, Westfield, N. J., has been named staff assistant at Tidewater Oil Company's new 130,000-barrel-per-day Delaware refinery. He was a process engineer assigned to the Delaware project. He joined Tidewater in 1946 and was named a process engineer last year.

Lester Ginsburg, vice president of Electric Bond and Share Company, has been elected to the board of Escambia Bay Chemical Corporation. The company, is owned jointly by Electric Bond and Share, New York; United Gas Corporation, Shreveport, and National Research Corporation, Cambridge, Mass.

Robert Gillespie has been appointed a managing director of The British Petroleum Company, Ltd. He fills a vacancy caused by the retirement of E. H. O. Elkington. Gillespie joined The British Petroleum Company in 1922. Elkington

don't let your heat exchangers get clogged like this...

"IN-PLACE" chemical cleaning now quickest way to maintain bundle efficiency.

With Oakite chemical circulation method you can now clean heat exchangers in place. And here are a few of the many advantages awaiting you:

- **fast, thorough soil removal**
- **greatly reduced off-stream time**
- **elimination of costly manual methods**
- **greater safety and longer life for tube bundles**
- **plus the supervisory services of an experienced Oakite technician**
- **free drawings and control equipment**

For the complete story on heat exchanger cleaning by Oakite send for new 48-page Booklet "What Petroleum Men Should Know to Simplify Cleaning". Or write for the name of your local Oakite Technical Service Representative. No obligation. Oakite Products, Inc., 50B Rector Street, New York 6, N. Y.

SPECIALIZED INDUSTRIAL CLEANING

OAKITE

MATERIALS · METHODS · SERVICE

SCIENCE

Export Division Cable Address: Oakite

Technical Service Representatives in Principal Cities of U. S. and Canada

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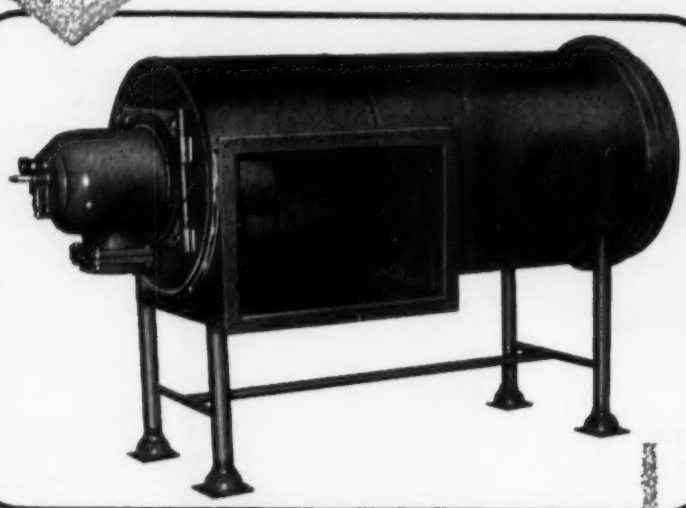
THERMAL TYPE CA DIRECT FIRED AIR HEATERS



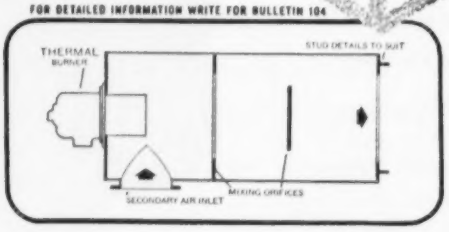
COMPACT . . . EASILY INSTALLED

Readily fitted to ovens, kilns, spray dryers, etc., the THERMAL Type CA Air Heater is an ideal source of heat where products of combustion may be mixed with the air. Oil, gas or combination firing is available without change in heater construction.

NO REFRACTORY REQUIRED . . .

The THERMAL High Velocity Burner built into the heater permits combustion to be substantially completed within the burner itself. Thus the heater is basically a mixing chamber wherein the products of combustion are mixed with the air being heated. Refractory is not normally used. Successful applications have been made ranging from under 200,000 BTU/hr. to over 20,000,000 BTU/hr. and at all pressure levels.

FOR DETAILED INFORMATION WRITE FOR BULLETIN 104



UNITIZED CONSTRUCTION

Initial cost and upkeep is kept at a minimum through the use of all welded, all metal construction. The CA Air Heaters are normally supplied as complete "package" installations.

OTHER THERMAL PRODUCTS & SERVICES

Gas, Oil & Combination Gas-Oil Burners • Heat Exchangers • Submerged Combustion • Combustion & Heat Transfer Engineering

THERMAL

Thermal Research & Engineering Corp.

CONSHOHOCKEN • PENNSYLVANIA

REPRESENTATIVES IN PRINCIPAL CITIES

Men in the Industry . . .

joined the organization in 1921 and from 1929 to 1937 was general manager in Iran and Iraq. He was appointed a managing director in 1947.

Bruce K. Brown, president of Pan-Am Southern Corporation, will become president of Petroleum Chemicals, Inc., later this year when Pan-Am Southern is merged with its affiliate, American Oil Company. He is a former deputy administrator of the Petroleum Administration for Defense.

Headquarters of Petroleum Chemicals will be moved from New York to New Orleans. The company is now headed by **L. F. McCollum,** president of Continental Oil Company. It is owned jointly by Cities Service Company and Conoco.

Wallace E. Avery has been elected secretary of The Texas Company, succeeding **Walter G. Elicker** who has retired after 38 years with the company. Avery has been assistant secretary since early 1954. He started with the company in 1945 as an attorney in the Los Angeles office and served as assistant general manager of the Industrial and Public Relations department. From 1942 to 1945 he was assistant chief counsel for the Petroleum Administration for War.

Avery

William E. Hanford, director of research for The M. W. Kellogg Company, was one of three scientists to receive honorary degrees of Doctor of Science at the 135th Commencement of the Philadelphia College of Pharmacy and Science. Dr. Hanford completed his undergraduate training at the Philadelphia college and his graduate training at the University of Illinois.

Charles A. Chipman of Bolivar, N. Y., has been reelected to his fourth one-year term as president of the Pennsylvania Grade Crude Oil Association. Other officers who were reelected include: **George J. Hanks,** president of South Penn Oil Company, Oil City, first vice president; **A. C. Simmons,** Simmons Oil Company, Bradford, second vice president; **Fayette B. Dow,** Washington, vice president and general counsel; and the following, all of Oil City:

Samuel Messer, Quaker State Oil Refining Corporation, treasurer; **F. W. Alcorn,** Pennzoil division, South Penn Oil Company, **C. L. Suhr,** South Penn Oil Company, and **C. G. Johnson** of Quaker State Oil Refining Corporation, assistant treasurers, and **W. C. Wenzel,** executive manager.

Clarence E. Means will be operations superintendent of the natural-gasoline plant Cities Service Oil Company (Delaware) is building, with Forest Oil Company, on the Roberts Ranch in Midland County, Texas. **Frank Snyder,** with Cities Service at Hutchinson, Kansas, is succeeding Means as superintendent of the company's Burr-

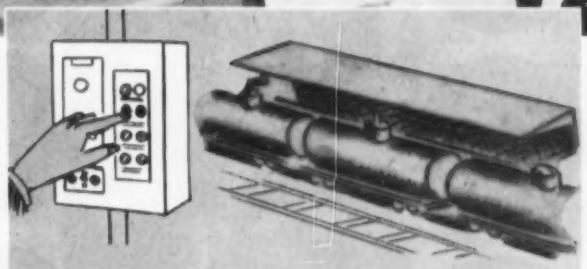
For more data on advertised products, use Readers' Service Cards, last page.

HANDLE YOUR PRODUCT FASTER...at less cost

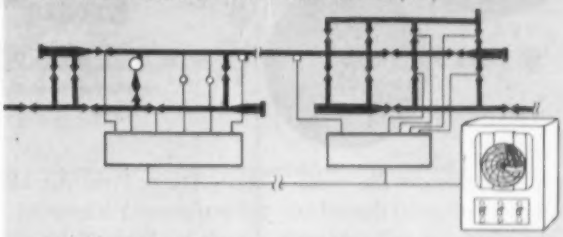
Sparton Control Systems now offer greatest opportunity yet for streamlining product handling—at the well field, refinery, processing plant, storage depot, distribution point or across open miles of pipeline.

They combine a variety of control techniques—all time-proven through years of communication use—into custom-tailored systems containing standard plug-in modules. These systems enable alarming, discreet control, metering, proportioning, scanning—with the ability to compress a wealth of control signals or data onto a standard two-wire and ground transmission line.

Available as complete systems, including control centers, or for integration into your existing set-up. Full details in new control catalog.



LUBE OIL FACILITY required remote control of 87 different pumps from 11 different mixing stations. Sparton solved problem with Bipolar DC Discreet Control System that eliminated verbal order errors, saved delays, enabled faster product switch. Operator at each supervisory point quickly selects pump or pumps assigned to his positions and controls operation with ON-OFF-EMERGENCY OFF key. Lamps indicate PUMP ON or PUMP EMERGENCY OFF for each controlled pump.



MEASURED MILE on Michigan pipe line enables more accurate product measurement, better switching control. Supervisor at station "D" controls stations "A", "B", and "C" over 20 miles of line. Line pressure and product temperature transducers transmit data to control point. Pick-ups at "A" and "B" transmit departure and arrival impulses to enable accurate measurement to transmission time of barrel.

Sparton

CONTROL SYSTEMS

SPARTON CONTROL SYSTEMS DIV.
The Sparks-Withington Company
Jackson, Michigan

☐ Please send literature. ☐ Have representative call.

Name_____ Title_____

Company_____

Address_____

City_____ State_____

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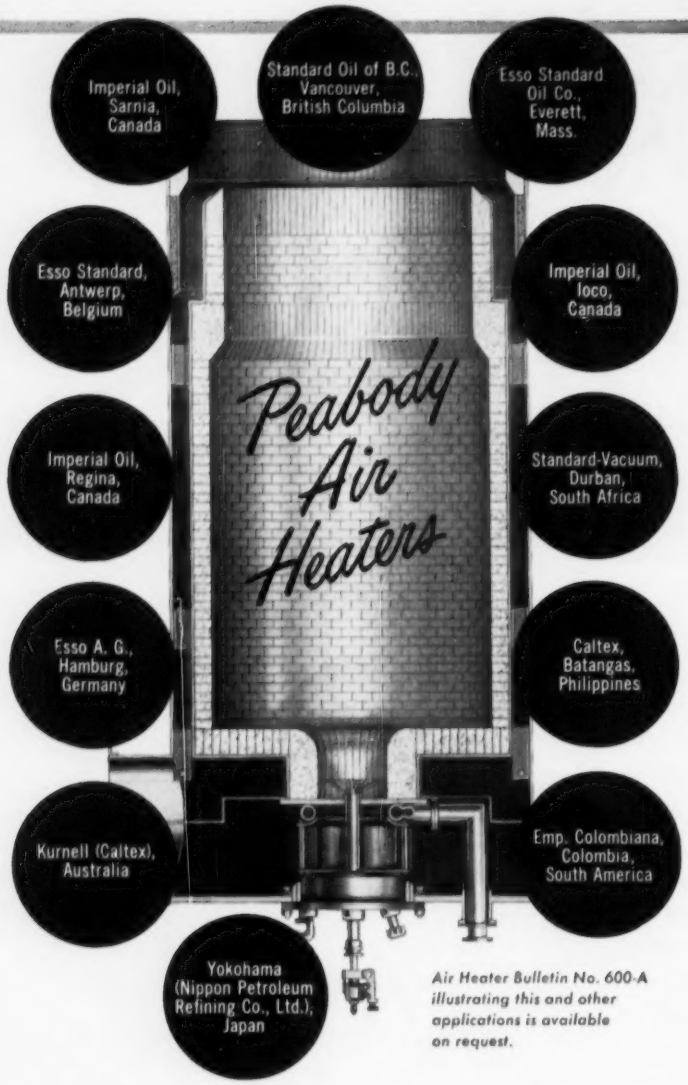
Known by the company they keep


Imperial Oil, Sarnia, Canada
Standard Oil of B.C., Vancouver, British Columbia
Esso Standard Oil Co., Everett, Mass.
Esso Standard, Antwerp, Belgium
Imperial Oil, Ioco, Canada
Peabody Air Heaters
Imperial Oil, Regina, Canada
Standard-Vacuum, Durban, South Africa
Esso A. G., Hamburg, Germany
Caltex, Batangas, Philippines
Kurnell (Caltex), Australia
Emp. Colombiana, Colombia, South America
Yokohama (Nippon Petroleum Refining Co., Ltd.), Japan

Air Heater Bulletin No. 600-A illustrating this and other applications is available on request.

THROUGHOUT the world Peabody Direct Fired Air Heaters are used wherever dependability of performance is essential. As examples, we point with pardonable pride to Peabody Installations on patented Esso Research and Engineering Company's Model IV Cat. Crackers, which are available under license to the industry. For this service the Peabody Air Heater is readily incorporated into the base of the regenerator.

The Peabody design utilizes a positively air-cooled furnace with a portion of the air to be heated by-passed around the refractory-lined combustion chamber. This important feature makes for high combustion efficiency in a compact piece of equipment.

PEABODY ENGINEERING CORPORATION

580 FIFTH AVENUE, NEW YORK 36, N. Y.

OFFICES IN PRINCIPAL CITIES

PEABODY LIMITED • LONDON, S.W. 1, ENGLAND

S-C90

Men in the Industry . . .

ton, Kansas, gasoline plant. **John Paxton** is being transferred from Cities Service's Chico, Texas, gasoline plant to Hutchinson where he will replace Snyder as assistant superintendent of a LP-Gas storage terminal, and **Wayne Fling**, with Cities Service in its Gasoline division office at Bartlesville, is being sent to Chico to succeed Paxton as operations superintendent.

Robert E. Witt has been appointed manager of asphalt sales for Lion Oil Company. He succeeds **Inghram Grayson** who retired after 28 years with the company. Witt has been assistant manager of Lion's asphalt sales since 1943. He started with the company in 1934.

U. T. Greene, an executive of Diamond Alkali Company, has been made director of the Business and Defense Services Administration's Chemical and Rubber division, in the Commerce Department. Dr. Greene had been coordinator of Diamond Alkali's Commercial Development department for more than a year.

D. Woodson Ramsey, Jr., coordinator of the marketing oerations of Standard Oil Company (New Jersey), has been elected to the board of the affiliated Esso Research and Engineering Company. He replaces **William R. Scott,** who was elected to the parent company's board of directors.

R. Mayson Foster has been appointed general auditor, and **Adam P. Yung** has been appointed manager of the newly-formed Systems and Procedures division of Gulf Oil Corporation's Comptroller's department.

J. Earle Gray has been appointed assistant general manager of Tidewater Oil Company's Western division. Included in his duties as assistant to **Thomas L. Wark,** vice president and Western division general manager, will be the responsibility for helping conduct and coordinate the company's refining activities in the western U. S.

Grubb

Barnes

Lester H. Barnes, with Continental Oil Company at its Ponca City refinery 28 years, has been promoted to superintendent of the refinery. He succeeds **Loren D. Grubbs,** who will become regional manager of operations for Petroleum Chemicals, Inc., a Lake Charles concern which Conoco owns jointly with Cities Service Company. Named to replace Barnes as assistant superintendent of the refinery was **Wyatt L. Walker,** formerly superintendent of the Catalytic Cracking division.

Barnes started at the refinery as a laborer, worked part-time while completing his education, progressed through the

Men in the Industry...

ranks to power-plant foreman, and in 1948 was named maintenance and construction engineer. He became assistant superintendent of the refinery in 1953.

Grubb joined Continental at the Ponca City refinery in 1939. In 1946 later was named director of technical services for Cit-Con Oil Corporation, another Continental-Cities Service affiliate, and in 1951 became assistant superintendent at Ponca City. He was named superintendent of the refinery in 1954. In his new position, Grubbs will be in charge of all Petroleum Chemicals operations in the Lake Charles region.

Walker has been with Conoco at Ponca City since 1944. Starting as a technologist in the refinery, he subsequently became senior process engineer, assistant chief process engineer, and in 1954 was promoted to superintendent of the refinery's Catalytic Cracking division.

Bernard S. Friedman has been promoted to research associate of Sinclair Research Laboratories, Inc. He joined Sinclair in 1948 as an assistant division director, and is the author of 20 scientific papers and numerous patents in the fields of aviation gasoline, motor fuels, and petrochemical processes. He received his doctorate in chemistry at the University of Illinois in 1936.

Friedman

In 1952, he was chairman of the Chicago chapter, American Institute of Chemists, and currently is midwest chairman of the society's employee-employer relations committee. He is a past president of the Chicago Technical Societies Council.

Dayton H. Clewell has been named manager of Socony Mobil Oil Company Laboratories. The announcement was made by **Dallas R. Lamont**, director in charge of research. Until now Lamont has acted as manager of the company's research laboratories.

Prior to his new appointment, Dr. Clewell was manager of Magnolia Petroleum Company's research laboratories at Dallas.

F. A. Upson has been appointed chief engineer in the General Engineering department of Standard Oil Company (Indiana) at Whiting, Ind. **Otis J. Thompson** will succeed Upson as assistant chief engineer in the Process Engineering division, and **Wilbert J. Buxton** will replace Thompson as head engineer in charge of the Lube Oil and Asphalt section.

Upson will have charge of the Process Engineering division which includes the Alkylation and Finishing, Lube Oil and Asphalt, and Cracking sections. He succeeds **Harold M. Romig** who retired. Upson joined the company in 1939; Thompson has been with the company since 1940, and Buxton started in 1948.

Robert W. Sanders has been appointed by The Texas Company as supervisor of Chemical operations at its Lockport, Ill., works. And **William H. Roach** was named

install J.H.H. VOSS VALVES in your compressors for peak performance

(AIR • GAS • AMMONIA)

Our detailed proposal for improving efficiency of your compressor will be sent without obligation. Send name, bore, stroke, and speed of machine.

Peak performance, maximum efficiency, greater output, and lower power costs can be built into your oldest, and of course your newest, compressors by the installation of VOSS VALVES.

Check THESE VOSS VALVE ADVANTAGES:

- Quiet, vibration-free operation
- 20 to 60% more valve area
- less power consumption
- minimum pressure loss
- utmost safety
- normal discharge temperature
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WIEDEKE

Announces Its NEW General Catalog

TUBE EXPANDERS

TUBE CUTTERS

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ACCESSORIES

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Heat Transfer Units
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The Gustav WIEDEKE Company
Dayton 1, Ohio

For more data on advertised products, use Readers' Service Cards, last page.

PALMER

presents

an outstanding improvement in

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external calibration

Full 3½" Dial Face

- No Sector
- No Pinion
- No Linkage
- Constant Accuracy
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PALMER

THERMOMETERS, INC.

Norwood Ave., Cincinnati 12, Ohio

Mfrs. of Industrial Laboratory Recording and Dial Thermometers

Men in the Industry . . .

chief chemist at the company's Eagle Point works at Westville, N. J.

Sanders, who will be in charge of operations at Texaco's new ammonia plant at Lockport, joined the company in 1932. He had been chief chemist at the Eagle Point works since 1949.

Roach has been on loan from The Texas Company since 1954 to Iranian Oil Refining Company, N. V. He joined Texaco in 1934. From 1953 to 1954 he was chief chemist at the company's Lawrenceville, Ill., works.

Arthur M. Sherwood has been elected secretary of Socony Mobil Oil Company. Formerly assistant secretary, he succeeds **William D. Bickham,** who retired after 27 years with the company. Retiring after 29 years with the company was **Paul J. Buttles,** who also has been an assistant secretary. **Theresa Jean Lutz** and **James J. McKay** were elected assistant secretaries to succeed Sherwood and Buttles. Miss Lutz is the first woman to become an officer of Socony Mobil.

Don E. Kennedy has been appointed a technical associate in the Research department of Standard Oil Company (Indiana) at Whiting, Ind. And **William G. Stanley** was named a group leader and transferred to the company's laboratory at Seymour, Ind. Kennedy joined the Research department at Whiting in 1954; Dr. Stanley became associated with the company's Whiting laboratories in 1951.

Dr. Adalbert Farkas has joined the Research and Development division of Houdry Process Corporation as section chief in exploratory research at the Houdry Laboratories in Linwood, Pa. He will direct research on new chemicals and chemical processes.

Farkas

Dr. Farkas, who is program chairman for the First International Catalysis Congress which will be held in Philadelphia in September, was formerly with the Barrett Division of Allied Chemical and Dye Corporation at Glenolden, Pa.

After taking Ph.D. degrees in physical and industrial chemistry at Frankfurt University and the Technical University of Vienna, Dr. Farkas was a Research Fellow at Frankfurt, Cambridge and Jerusalem Universities, conducting studies on parahydrogen, heavy hydrogen, heavy water, and in reaction kinetics and catalysis. Later he worked on oxygenated derivatives of petroleum hydrocarbons and diesel fuel improvement with Union Oil Company in California. He holds 10 patents and has authored more than 60 books and technical papers.

Robert L. Meuleners, of Galveston, has been named to the new position of director of technical service of the Research and Development department of The American Oil Company, and will assist **John E. Kasch,** manager of research and development in the New York general offices. He joined the company in 1944 as a chemical engineer in technical service and process design at its Texas City re-

NATIONAL AIROIL

Oil Burners

OF THE STEAM AND MECHANICAL TYPES NOW COMBINED INTO

Dual Stage BURNERS

Now, at last, the inherent advantages of *both* systems of fuel oil atomization are *profitably* yours . . . within the one, new NATIONAL AIROIL Dual Stage Burner.

45 years of combustion equipment design and manufacture are in back of the Dual Stage Oil Burner . . . and, it has been thoroughly tested and proved in the field for firing: Petroleum Processing Heaters; Rotary Kilns; H.R.T., Scotch Marine and Water Tube Boilers; etc.

Available in three sizes, the NATIONAL AIROIL Dual Stage Burner fires all grades of fuel oil from No. 2 to No. 6, with a ready capacity of 80 to 300 g.p.h. Further, for a perfect flame pattern, we would recommend using with the Dual Stage Burner either the NATIONAL AIROIL Universal Register for forced draft or, the NATIONAL AIROIL Tandem Unit for natural or induced draft furnaces.

Get detailed descriptions, illustration, and specifications in NATIONAL AIROIL Bulletin 25.

- OIL BURNERS and GAS BURNERS for industrial power, process and heating purposes
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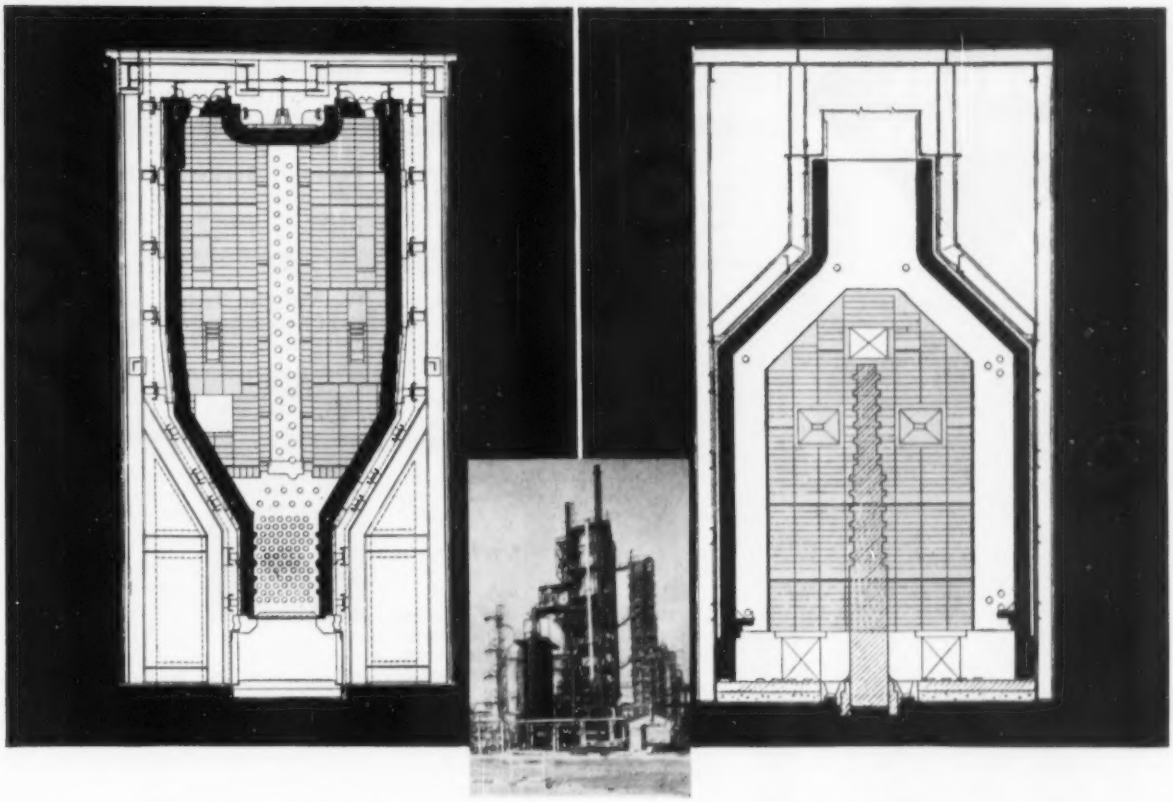
Profitable trends in the use of refractories



Laclede-Christy offers simplified way to get exact-purpose refinery refractories

It's highly profitable, of course, to use refractories exactly suited to each application. There's a simple way to do this. That is to rely upon one source which offers you each refractory type and grade that you may need—plus the quality and service you expect.

Laclede-Christy produces a variety of castable refractories for refinery use—to meet a wide temperature range. Two are particularly successful in refinery vessel applications—Porelite V.L. for its high insulating properties and lightness, and Firmcast for its extra strength and abrasion resistance.

Where you may need suspended arch and sectionally supported wall construction, Laclede-Christy again provides exact-purpose refractories. In fact, Laclede-Christy offers the most extensive experience obtainable in the engineering of suspended arch and wall construction.

If you need help to determine your exact-purpose refractory, Laclede offers that too. So, for a profitable trend in your use of refractories, get together with Laclede-Christy soon. A representative is nearby.

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DIVISION OF H. K. PORTER COMPANY, INC.

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For more data on advertised products, use Readers' Service Cards, last page.

Analyze for
HYDROGEN SULPHIDE

- 0-10 parts per million.
- 1 to 8 pickup points.
- Indicating and recording.

DAVIS ELECTRO-CONDUCTIVITY ANALYZER

Send for Bulletin 11-70

DAVIS INSTRUMENTS

Division of
Davis Emergency Equipment Co., Inc.
164 Halleck St.,
Newark 4, N. J.

Men in the Industry . . .

finery and since 1953 has been assistant director of research and development in charge of the technical service division at the Texas City refinery.

T. J. Oleszko has been named assistant manager of operations for the Aurora Gasoline Company, Detroit, Mich. Formerly he was operations superintendent, and was succeeded in that post by **Harry Murphy**, formerly day foreman of the cracking plant. **Russell Murphy** has been named cracking plant day foreman.

G. T. Burress has been promoted to the position of group leader, methods development-inorganic group in the Research and Development department of the American Oil Company, Texas City.

The methods development-inorganic group, newly established within the Analytical division of Research and Development, will be concerned with devising and improving analytical techniques and methods used to analyze research and process materials. A second group is concerned with organic procedures.

Burress has been associated with Amoco since June, 1951.

J. M. Evans has been named assistant vice president of Standard Oil Company of California to provide engineering counsel to Standard's operating companies. Evans, previously Chief Engineer, has been engaged in design and construction activities since joining the company in 1915.

Succeeding him as Chief Engineer and head of the company's Engineering department is **E. S. Warner**, who has been Assistant Chief Engineer since 1947.

Joe D. Walk has been named manager of economics in the Manufacturing department of The American Oil Company, and will assist **Roy J. Diwoky**, general manager of manufacturing in the New York general offices. He joined the company in December, 1945, as a chemical engineer at its Texas City refinery. In 1950, he was transferred to the El Dorado, Ark., refinery of Pan-Am Southern Corporation as assistant director of the Technical department, and in 1952 was named technical director at El Dorado. Since 1954 he has served in New Orleans as manager of technical service in the Manufacturing department of Pan-Am Southern.

Walk

Sam B. Becker and **Everett A. Johnson** have been named to the positions of senior patent attorney in Standard Oil Company (Indiana's) Development and Patent department, Chicago.

Becker, who joined Standard Oil in 1937, is an inventor and co-inventor of petroleum and chemical processes for which 11 U. S. and two foreign patents have been granted. Johnson has been with the company since 1940 and holds 35 U. S. and foreign patents, mostly in the fields of catalytic refining and oil production.

M. E. Houser, Jr., has been promoted to superintendent at the Republic Oil Refining Company refinery in Texas City. He succeeds **D. B. Smith**, who resigned to enter the refinery-construction business. Houser was a field engineer with Universal Oil Products Company when he joined Republic in 1950 as chief process engineer. Also receiving a promotion at the Texas City refinery was **C. H. Barre**, named coordinator of manufacturing.

Peter J. Berkeley, Jr., has joined Esso Research Laboratories at Baton Rouge. He recently graduated from the University of Colorado with a degree in chemical engineering.

W. Vaughn Ischie was elected vice president and general manager of manufacturing, Sinclair Refining Company. He succeeds **T. B. Kimball**, recently named director of manufacturing.

Ischie

Ischie joined Sinclair Refining as a member of the Research department at the East Chicago refinery in 1920. In 1930, he was transferred to the Manufacturing department, later becoming operating superintendent of the East Chicago refinery. In 1952, he was named director of the Foreign Refining division of the Petroleum Administration for Defense. On his return to the company in 1953, he was appointed assistant to the refineries manager in the New York office.

Donald W. Weir has been named assistant to the president of Arkansas Louisiana Gas Company, a new position in the company. Weir will be in charge of personnel, employe welfare and training, safety programs, community relations, wage and salary administration, labor relations, organization problems and efficiency studies, according to the announcement. Since joining Arkansas Louisiana Gas, Weir has served as junior engineer, in statistical, budget, tax and insurance work, and for the past three years has been personnel manager for the company.

William F. Ryan, vice president, director and senior consulting engineer of Stone & Webster Engineering Corporation, Boston, has been nominated as president of the American Society of Mechanical Engineers and will be installed at the society's annual meeting in New York in November, after a letter ballot of the organization's 41,000 members.

Dr. Ryan joined Stone & Webster Engineering Corporation in 1929 as a mechanical engineer and was named a vice president in 1950 after having served as assistant chief mechanical engineer, assistant engineering manager and engineering manager.

Charles B. Wallace, of Magnolia Petroleum Company's Legal department, has been appointed general counsel for the company. He succeeds **Earl A. Brown**, also a director and vice president of the company, who has retired.

Wallace has been in charge of litigation for Magnolia since 1951. Brown, who

For more data on advertised products, use Readers' Service Cards, last page.

This clad steel can do anything solid high alloy can do!

...and think of the difference in cost!

Clad steel demonstration unit featured at the Nat'l Assoc. of Corrosion Engineers show.

COMPARE THE VALUE!

■ Throughout the petroleum industry, clad steel has proved its value as a modern construction material for tanks and pressure vessels.

Clad steel gives you the protection of solid high alloy—at a down-to-earth cost! In fractionating towers and desulphurizers, as in so many other applications, clad steel is saving money for hundreds of users by adding to equipment life, simplifying maintenance, providing valuable flexibility that permits repeated changes in equipment to suit changing needs.

Lukens is headquarters for clad steels of all kinds. A selection of 16 cladding and 11 backing metals gives you practically unlimited combinations to meet virtually any conceivable need!

For more information, consult your equipment builders or write Manager, Marketing Service, Lukens Steel Company, 840 Lukens Building, Coatesville, Pennsylvania. Outline your interests and we'll show you in detail just why we say *clad steel is the ideal material for long range economy.*

SEE FOR YOURSELF!

ECONOMY — high-alloy layer assures corrosion resistance, long equipment life.

STRUCTURAL STABILITY — low-cost backing steel provides strength and rigidity.

DESIGN FREEDOM — integral bond allows design and fabrication of shapes to meet process and space needs.

LUKENS CLAD STEELS

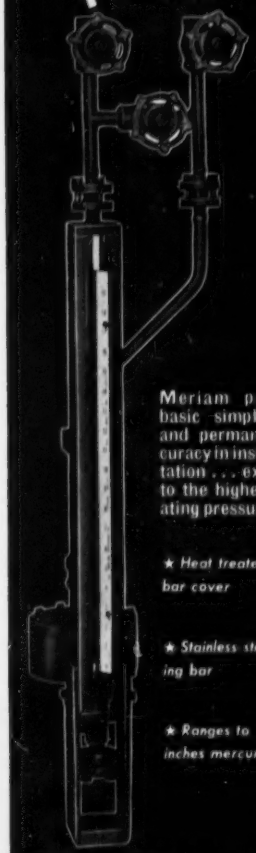
LUKENS

STAINLESS-CLAD • NICKEL-CLAD • INCONEL-CLAD • MONEL-CLAD

Producers of the Widest Range of Types and Sizes of Clad Steel Plates and Heads Available Anywhere

UNMATCHED ACCURACY
at highest working pressures

At pressures up to 2000 psi, this Meriam Manometer provides critically accurate flow or differential pressure measurement. Constructed of solid bar stock steel, all parts are precision fitted, hand lapped. Each unit is cold hydraulic tested to 5000 psi.



Meriam provides basic simplicity... and permanent accuracy in instrumentation... extending to the highest operating pressures.

★ Heat treated glass bar cover

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★ Ranges to 70 inches mercury

Write for Bulletin C-12.

Meriam Manometer Instrumentation
...for pressures, vacuums, flows, liquid levels.

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INSTRUMENT COMPANY
10920 Madison Ave. • Cleveland 2, Ohio

Men in the Industry...

has been on the company's legal staff since 1936, became general counsel in 1951. He was elected vice president and director the following year.

F. M. Orr has been promoted to technical specialist in the Technical Service division at Humble Oil & Refining Company's Baytown refinery. **J. G. Lillard** was advanced to senior chemical engineer and **D. E. Nicholson** to senior research chemist in the Research and Development division, and **Clinton W. Bates** was promoted to supervising engineer in the Engineering division.

John T. McCoy, formerly divisional research and development supervisor of Tidewater Oil Company, has been named manufacturing department coordinator, representing the company's new Delaware Flying A Refinery in the divisional offices at New York City.

McCoy

McCoy, an MIT graduate, joined Tidewater in May, 1927. He has been active in petroleum industry technical committees and is currently a member of the board of directors of the Coordinating Research Council.

Charles L. Fleming has been appointed deputy coordinator of petroleum products and medical research for Esso Research and Engineering Company. **John G. McNab** was named director of the Products Research division, and **Neil V. Hakala** was made associate director.

Dr. Fleming succeeds **Robert M. Shepardson** who was appointed assistant manager of the Marketing Development division in the Marketing Coordination department of the parent Standard Oil Company (New Jersey). Dr. McNab succeeds Dr. Fleming; Dr. Hakala, who was an assistant director of products research, succeeds Dr. McNab, and George A. Rial succeeds Dr. Hakala.

J. S. Parker, Jr., formerly manager of project engineering for The Lummus Company in New York, has joined the company's Houston division as general manager of engineering. Parker previously was with Societe Francais des Technique, Lummus' French subsidiary, for five years. He was appointed manager of the subsidiary in 1952.

Parker

R. C. Frederick, who prior to November 1955, has spent 28 years with Gulf Oil Corporation, has rejoined the company in the Planning and Economics department. In his new position, Frederick will be on the staff of **P. H. Bohart,** vice president, as planning coordinator for natural-gas liquids, gasolines and liquefied petroleum gas. From November 1955 until June 1956, he was vice president in charge of gas purchases and sales for Pacific Northwest Pipe Line Corporation, headquartered in Houston.

Wilburn T. Askew has been elected as the first resident president of Sun Oil Company, Ltd., of Canada. Until recently manager of the parent company's Marcus Hook refinery, Askew succeeds **Joseph N. Pew, Jr.** Continuing as managing director of the Canadian concern is **John J. Schafer,** who will serve as consultant to Askew.

Askew

The new president has been with Sun Oil Company 25 years. He started as a chemical engineer at Marcus Hook and moved through the grades of the Alkylation and Gas division to assistant superintendent, superintendent, assistant manager and, in 1954, to manager of the refinery. Earlier this year he attended the Advanced Management Course at Harvard University's School of Business Administration.

R. E. Howe heads a list of five new managers of operating divisions created by the reorganization of Sinclair Refining Company's Manufacturing department. Named to manage the Processing division, he will advise on improving operations of existing equipment and approve all process designs in future projects.

- **J. E. Bell,** who was named to head the Engineering and Maintenance division, will direct engineering for existing refinery equipment and approve engineering on future projects.
- **G. F. Kuhn,** appointed manager of the Refinery Production division, will handle crude and project evaluations, cost studies and study of long-range projects dealing with over-all department economics.
- **K. A. Beach,** head of the new Asphalt and Chemical division, will direct the supply of asphalt to the Sales department and chemicals to the Chemical department and approve specifications on all products except lubes and greases.
- **A. D. Hill,** placed in charge of the Lube Oil Production division, will be responsible for all lube oil and wax matters, approve all lubricating and grease formations and direct barrelhouse and laboratory operations.

A sixth division, Light Oil Production, has been created, but no manager was named. In the interim, Kuhn will also serve as manager of that division.

Arnold Nelson of Walnut Creek, Calif., has been promoted to employe relations supervisor at Tidewater Oil Company's refinery, Associated, Calif. **Oscar Larson** is refinery manager.

Formerly assistant to the company's employe relations supervisor for its western area with headquarters in San Francisco, Nelson replaces **Louis L. Kissinger** of Concord, Calif., deceased.

He will be responsible to Larson for personnel management, labor relations, employe training, plant guard service, safety, and fire protection.

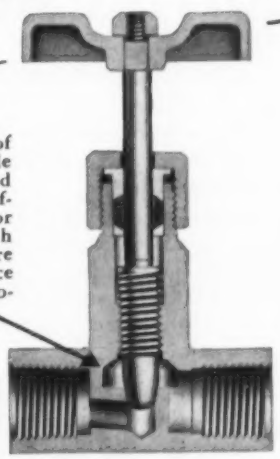
For more data on advertised products, use Readers' Service Cards, last page.

MAXIMUM WORKING PRESSURE
10,000 PSI
for water, oil or gas

- Body and stem guide extra heavy bar stock fused into one piece.
- Valve stem 416 stainless steel.
- Packing special one-piece "Marpak" moulded ring.
- Bodies marked in accordance with MSS regulations.

ONE PIECE

The stem guides of conventional needle valves are screwed into bodies—this often causes leakage or blow-outs. Marsh Needle Valves are fused into one-piece by exclusive "Conoweld" process.



The Ultimate in Needle Valves

Here is one of the crowning achievements of Marsh research, design, and manufacturing skill. It is the first needle throttling and shutoff valve to combine *all* of the qualities called for today in this highly critical and ever broadening field.

It is a valve that has strength and safety to spare . . . rated for pressures up to 10,000 psi—equally efficient in the lower ranges. A product of Marsh instrument-making and valve manufacturing experience, it combines instrument-like precision with the ruggedness that distinguishes all Marsh valve specialties.

The illustrations tell the story of new thinking; new standards. Body and stem-guide are machined from extra-heavy carbon steel bar stock. Still greater strength and rigidity are achieved by fusing the stem-guide into the body. The complete fusion of guide and body is accomplished by the exclusive Marsh "Conoweld" process.

There are two big advantages to this one-piece construction: (1) It eliminates the danger of unscrewing the valve from the body when opening—a frequent cause of leakage, even dangerous blow-outs (2) It permits perfect line-up of threads and seat. As a result, Marsh valves are easier to operate even at high pressures.

The precision-machined stem is 416 stainless steel. Stem threads are fine pitch for extra strength and fine, controlled regulation. Notable advancements are special "Marpak" one-piece, non-binding longer-lasting packing; deep thread chambers, keeping inlet and outlet piping away from ports and contributing excellent flow characteristics. Entire packing nut and packing gland are electro-zinc plated, preventing corrosion and giving the valve a handsome, plated exterior. The rugged malleable handle is finished in heavy baked enamel.

The new needle valve line includes globe and angle patterns with double female connections in sizes ⅛", ¼", ⅜", ½", ¾" and 1". Also globe and angle valves with male inlet and female outlet in sizes ¼" and ½". *Complete stock carried at our Skokie, Illinois factory and also at our branch plant in Houston, Texas.*

Write today for catalog giving complete details.

MARSH INSTRUMENT CO. *Sales Affiliate of Jas. P. Marsh Corporation*
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Houston Branch Plant: 1121 Rothwell St., Sect. 15, Houston, Texas
Marsh Instrument & Valve Co. (Canada) Ltd.,
8407 103rd St., Edmonton, Alberta

MARSH

"THE STANDARD OF ACCURACY"

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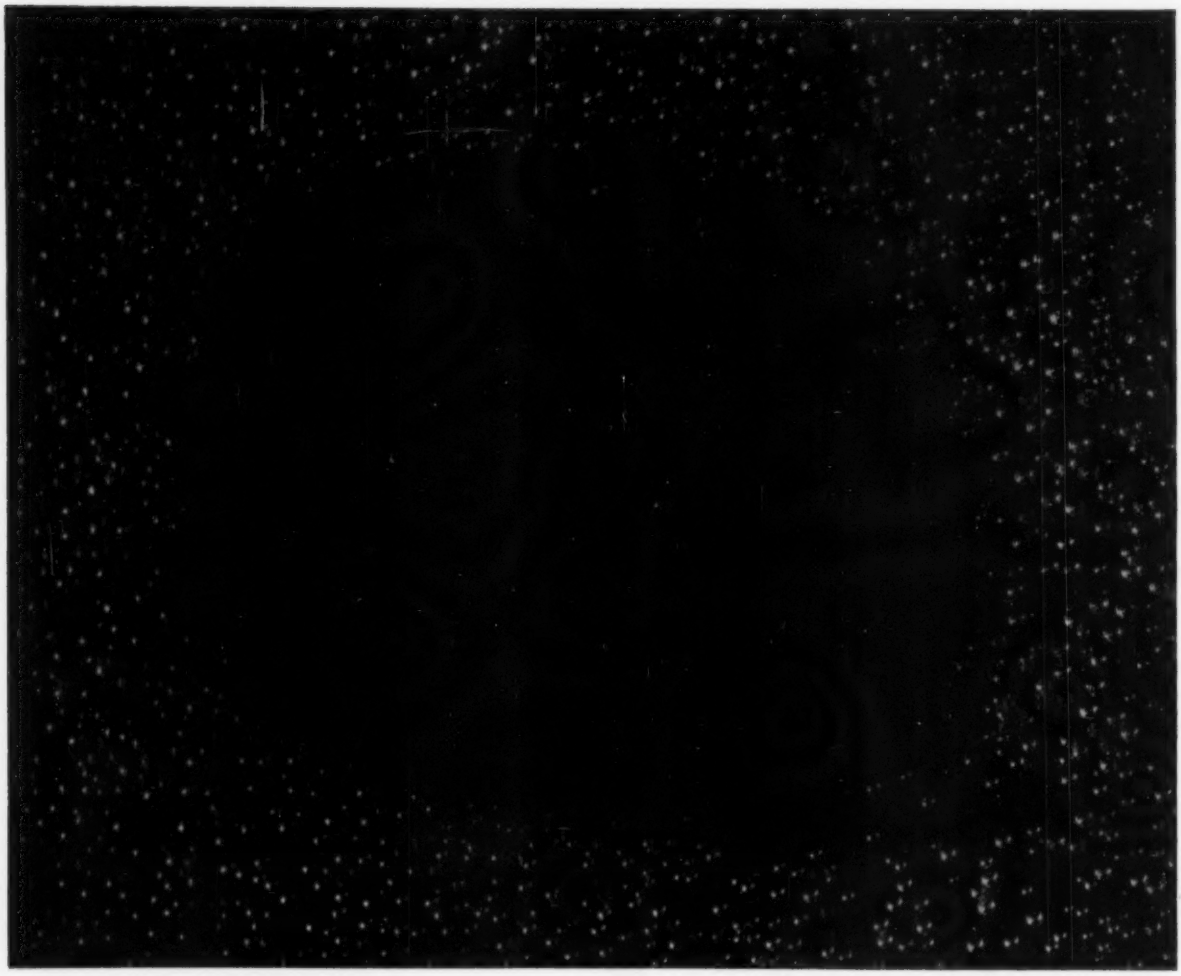

An Inside-Out View

CORROSION INHIBITOR AT WORK

Here's an external view of what takes place internally in refinery equipment. This photograph shows a piece of mild steel. The center has been treated with Polyrad. The entire piece of steel then was immersed in an acidic environment. The tiny bubbles of hydrogen show the beginning of corrosion. But the center portion remains a safety island—thanks to Polyrad.

This photographic impression bears out what most refinery operators already know—that Polyrad is an effective inhibitor. It will economically reduce corrosive damage with an average treatment of about 1 quart of Polyrad per 1,000 barrels of fluid.

Polyrad's powerful detergent action also serves to loosen organic and inorganic deposits, allowing them to be removed in the fluid stream.

All around the refinery, Polyrad can help maintain throughput, increase heat transfer, reduce metal loss, and cut down-time for maintenance. A Hercules technical representative will be glad to explain how Polyrad can be used to combat your specific corrosion problem.

Pine Chemicals Division, Naval Stores Department

HERCULES POWDER COMPANY

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NA56-4

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FILMING AMINE INHIBITOR

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What Suppliers Are Doing . . .

Serrill Ackerman Bartlett Kirby Slay Land Mathews Smith Comerford

Joseph L. Serrill, Jr., has been promoted to supervisor in charge of process industries in the Market Development division of **Leeds & Northrup Company.** Serrill, who joined the company in 1940, was one time with the Naval Research Laboratory and later worked in the Instrument branch of the War Production Board.

A. W. Ackerman has been added to the New York sales staff of **Badger Manufacturing Company.** Previously a member of the New York contract sales staff of The Lummus Company, Ackerman also was one time associated with the Refining department of The Texas Company.

R. F. Bartlett has been promoted to manager of the Dallas branch of **Copper-Bessemer Corporation.** He will be responsible for supervising sales, engineering and service contacts in that area for the pipe line, refining and petrochemical industries. Bartlett has been with the company since 1934 in the application of engines and compressors.

Harry Kirby has been appointed district manager for **Jas. P. Marsh Corporation** at Cleveland. He will direct the company's sales efforts in Ohio, Pennsylvania and the greater part of New York. Kirby has been with the company since 1939.

Norvell F. Slay has been made purchasing agent for **W-K-M Manufacturing Company, Inc.** He previously was factory manager of the former Key Company, and had been with that company 22 years. His headquarters are in the recently-completed W-K-M plant in Houston.

Frank N. Land has been named senior field engineer for **Chiksan of Canada, Ltd.** He joins the company after six years with Lynn Macleod Engineering Supplies, Ltd., a Chiksan sales representative. He was manager of the firm's Morrison Brass division. Before that, he was with Crane, Ltd.

Richard C. Mathews has joined **Davison Chemical Company Division** of W. R. Grace & Company as a field service engineer in the Petroleum Catalyst department, stationed in the company's Houston office. He succeeds John Benedict, who was transferred to New York. Mathews formerly was with Standard Oil Company (Indiana).

Jack H. Smith has been made director of Air Control and Research for **Kaiser Steel Corporation** at its steel plant at Fontana, Calif. He had been technical engineer for the company's program of controlling stack emissions throughout the plant. He started with the company in 1949.

Wilbur J. Comerford has been appointed specialty-products engineer by the Alloy Tube division of **The Carpenter Steel Company.** He was field engineer for International Business Machines in Endicott, N. J., and Elizabeth, N. J., and later assistant to the vice president of National Lock Washer Company at Newark.

Sanger Rogers Dumser Anderson Jackson Sylvester Stoughton Benedict Tower

A. C. Sanger will be in charge of operations for three Ohio companies recently acquired by **A. P. Green Fire Brick Company.** They are The Pyro Refractories Company, Durex Refractories Company and Portsmouth Clay Refractories Company. Personnel of the companies will be retained, with their organizations continuing as in the past.

William O. Rogers, formerly with Texas Iron Works of Houston, has joined **Alco Products, Inc.,** as a regional sales representative at Odessa, Texas. Also named as representatives for Alco in the Southwest were **William L. Wilcox** and **W. W. Power.** Wilcox will headquarter at Houston, and Power will be located at Lafayette, La.

John M. Dumser, director of sales for **Wolverine Tube,** division of Calumet & Hecla, Inc., has been elected a director of the Detroit Sales Executive Club. A member of the club since 1953, Dumser has been active in program work both in planning and on the rostrum.

Clifford E. Anderson, with **W-K-M Manufacturing Company** since early this year, has been appointed chief research and development engineer. He formerly was senior development engineer with Cameron Iron Works, and for the past two years was an independent consulting mechanical design engineer. He is a member of the Texas Society of Professional Engineers.

Henry A. Jackson has been selected as manager of foreign operations for **Roots-Connersville Blower,** a division of Dresser Industries, Inc. He will be in Roots-Connersville's Foreign Operations office in New York. He assumes his new position with more than 20 years experience in industrial equipment and the import-export field, both in the U. S. and abroad.

Russell L. Sylvester, formerly with New York Air Brake Company, has joined **Rockwell Manufacturing Company** as chief engineer of its Central Valve Research and Development department in Pittsburgh.

Hooker Stoughton has been named by **Scovill Manufacturing Company** as manager of the Aircraft Fastener section of its Closure division. He will be responsible for research, product development, production and marketing for the division. Stoughton joined the company in 1939. He later served in the company's New York office. In 1949, he was transferred to Waterbury, Conn.

John Benedict has been appointed district sales manager with headquarters in the New York office of the Petroleum Catalyst department of **Davison Chemical Company Division** of W. R. Grace & Company. Benedict, who joined the company in 1950 as a field service engineer, has been in the company's Houston office since 1954.

R. G. Tower, now manager of **The Bristol Company's** Chicago office, will be manager of a new district office the company is opening in Denver. He has been with the company since 1922, when he joined the sales force in New York. Since

Suppliers . . .

then he has been manager in St. Louis, in the company's West Coast offices and in Chicago.

Byron Jackson Pumps, Inc., has made three new appointments. **R. A. Winsryg** has been appointed manager of the Los Angeles region. He previously served as manager of the Houston region. **E. L. Lindsey** has taken over as regional manager of the Houston area. He formerly held the position of Los Angeles regional manager. **Dean De Graffenreid** has been appointed assistant regional manager at Houston to aid Lindsey. Prior to this, De Graffenreid served as assistant to Robert Harcus, executive vice-president of Byron Jackson division of Borg-Warner Corporation.

The company also has transferred two of its men. **Jack Stewart** has moved from Houston to San Francisco to serve as assistant regional manager, assisting **Don T. Metz,** San Francisco regional manager. **Randy Oram,** sales engineer, has been transferred from New York to the Houston region as district manager, Dallas.

Wedgeplug Valve Company, an affiliate of Stockham Valves & Fittings, has moved its entire operation from New Orleans to the Stockham plant in Birmingham, Ala. The move was made to give the valve manufacturer larger production facilities. Both the company's production and sales forces were moved. They are now located at 4000 Tenth Avenue North, Birmingham.

Stebbins

Crabbe

Fisher Governor Company has appointed **Fred Crabbe** and **Jerry Stebbins** sales representatives for New York and the surrounding territory. Their organization will be known as Crabbe & Stebbins Company, with offices in Englewood Cliffs, N. J., and Albany. Crabbe joined the Fisher sales organization in 1943; Stebbins entered the New York sales office in 1947.

Lynn Maxwell and **William Conway** have also joined this company. Maxwell, who has two years sales experience with Fisher, will devote his attention to gas distribution equipment. He will work out of the New Jersey office. Conway has been with Fisher since 1953 and will head the Albany office.

Wolverine Tube, division of Calumet & Hecla, Inc., has appointed **B. J. Wuerthner** to the sales staff of its Mid-west district. Wuerthner will help to coordinate Midwestern district sales efforts for Wolverine at District headquarters in Evanston.

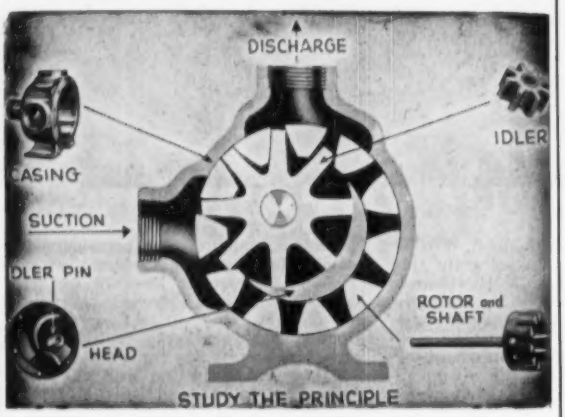
Westinghouse Electric Corporation has streamlined the activities of its Transportation and Generator division resulting in the appointments of six Engineering department managers. Each department manager reports direct to **A. M. Harrison,** division engineering manager. They are:

J. W. Batchelor, 19 years with Westinghouse, heads the Turbine-Generator engineering department; **M. R. Lory,** 28 years with Westinghouse, directs the A-C Motor and Generator engineering department; **E. H. Myers,** 19 years with Westinghouse, leads the D-C Motor and Generator engineering department; **E. C. Whitney,** 21 years with Westinghouse, guides the Water-Wheel and Synchronous Condenser engineering department; **G. L. Moses,** 33 years with Westinghouse, governs the activities of the Services engineering department; **R. A. Baudry,** 31 years with Westinghouse, leads the Development engineering department.

Fischer & Porter Company has made **Robert F. Lane,** assistant to the president, a member of the company's board of directors. Lane has been with the Hatboro, Pa., instrument manufacturer for 13 years.

Jones & Laughlin Supply Division has made two major personnel changes in its field sales structure. **Robert T. Bouldin,** formerly assistant district sales manager in the Northern Oklahoma district, was appointed district sales manager of the North Texas district, with headquarters at Wichita Falls, Texas. He succeeds **W. R. Layne** who has been assigned to the Southern Oklahoma district as general salesman with headquarters in Ardmore. Bouldin joined J&L Supply in 1935, as a storeman

Viking Operating Principle



Above are illustrated the major parts of the Viking Pump—casing, head, rotor and idler, separately and assembled. Imagine the rotor and idler in motion operating in a counterclockwise direction. Follow the course of the liquid from point of suction to point of discharge. Reverse direction will operate equally well. We invite your inquiries.

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cuts machine repair costs 80%—
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Practically any worn machine part—repaired for only 15 or 20% of replacement cost—in minutes and hours, instead of days or weeks.

Pump shafts • Impeller journals • Motor shafts
Rotor blades • Packing areas • Pump plungers

The list of metallizing users in the Petroleum field reads like a Blue Book of the industry. Here are just a few:

Cities Service Refining Co. — Ohio Oil Co.
Esso Standard Oil Co. — Phillips Petroleum Co.
Gulf Oil Co. — Socony-Vacuum Oil Co.
Imperial Oil Co. (Canada)

METCO

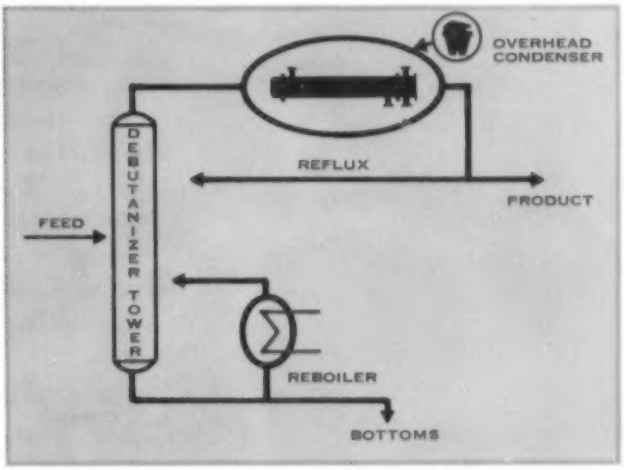
Metallizing Engineering Co., Inc.

1157 Prospect Ave., Westbury, L. I., New York • cable: METCO

In Great Britain: Telephone: EDGEWOOD 4-1300
METALLIZING EQUIPMENT COMPANY, LTD.—Chobham near Woking, England

Midwest Refinery Boosts Throughput 33%

- Integral finned condenser tube setting new heat transfer records
- Processing engineers take new look at extended surface condenser tube
- Roving reporter describes results of finned tube installations
- Manufacturer offers design information and operating data



by Ernest Dodd

DURING a recent swing through the major petro-refining areas of the Western States this writer was impressed by the amazing production records being established in plants using integral finned condenser tube. The tubing manufacturer is Wolverine Tube and the product is Wolverine Trufin® Type S/T.

It's pretty hard, for example, to ignore a 33% increase in throughput, particularly when it was obtained simply by retubing an existing overhead debutanizer condenser. In describing this increase to me, the Chief Processing Engineer of a large Midwest refinery, declared that his plant's overall U had shot up from 140 to 210.

He also stated that in retubing, Wolverine Trufin was completely interchangeable with the formerly used prime surface tube. Exactly the same tools and standard tubing techniques were used. He was actually gleeful as he described how use of the integral finned tube increased the heat transfer surface area approximately $2\frac{1}{2}$ times—*without any increase in unit size or weight.*

The principle of application of an extended surface tube to heat transfer problems has been well established for many years. However, its use in shell and tube condensers was not practical until Wolverine pioneered the use of integral finned tube. We predict that processing engineers in general are going to take a fresh look at this type of application as the good word spreads about the remarkable achievements of Wolverine Trufin Type S/T.

Design, Operating Information Obtainable From Manufacturer

Complete information on designing with extended surface tube, actual case histories and operating and fouling data are all described in a new Trufin Opportunity Book, according to an announcement by Wolverine Tube. The company maintains a Field Engineering Service for the assistance of any refinery or equipment fabricator considering the use of finned tube in heat transfer applications. Wolverine Tube's address is given below.

Wolverine Trufin is available in Canada through the Unifin Tube Co., London, Ontario

DIVISIONS OF CALUMET & HECLA, INC.
CALUMET DIVISION
WOLVERINE TUBE DIVISION
CANADA VULCANIZER & EQUIPMENT CO., LTD.
FOREST INDUSTRIES DIVISION
GOODMAN LUMBER CO.

WOLVERINE TUBE
Division of Calumet & Hecla, Inc.
1437 CENTRAL AVE., DETROIT 9, MICH.
Manufacturers of quality Seamless Tubing and Extruded Aluminum Shapes

SURE-FIRE ANSWERS TO YOUR CONDENSER TUBE NEEDS

PRIME SURFACE TUBE

Wolverine manufactures prime surface tubing in copper, copper-base alloys and aluminum in a wide range of sizes.

DUPLEX PRIME SURFACE TUBE

Here's a tube designed to handle two types of corrosion simultaneously. It is composed of an outer tube of one metal and a liner of another. The combination can be of any two alloys you need to meet special corrosive conditions.

DUPLEX TYPE S/T

This tube also is designed for specific corrosive conditions. Like Trufin, it has integral fins—will boost heat transfer efficiency.

If you're looking for the answer to increased heat transfer efficiency, chances are you'll find it among the Wolverine condenser tubes described on this page.

Supposing, for example, that you're faced with corrosive attack on both shell and tube side. The right tube for you is Wolverine Duplex because it gives you an outer tube of one metal mechanically bonded to an inner liner of an entirely different metal. The combinations can be of any two alloys you need to stop corrosion in its tracks.

On the other hand perhaps you're concerned with a lack of space—would like to reduce your replacement tube inventory. In this case just specify Wolverine U-Bend condenser tubes—you'll not only reduce inventory but you'll also slash retubing time.

One metal or two—finned or prime surface—you'll find that Wolverine has done its level best to help you come up with the right answer. It's the type of program that comes from years of metalworking experience plus a thorough knowledge of an industry's needs.

And if you're not quite sure where your trouble lies, Wolverine's Field Engineering Service can help you. FES is a staff of highly trained tubing technicians skilled in matters of corrosion, alloy selection, design, or fabrication. For complete information just write for Wolverine's Condenser Tube Catalog. It's your's without obligation.

DIVISIONS OF
CALUMET & HECLA, INC.

CALUMET DIVISION
WOLVERINE TUBE DIVISION
CANADA VULCANIZER
& EQUIPMENT CO., LTD.
FOREST INDUSTRIES DIVISION
GOODMAN LUMBER CO.

WOLVERINE TUBE

Division of Calumet & Hecla, Inc.
1437 CENTRAL AVE., DETROIT 9, MICH.
Manufacturers of Quality Controlled Tubing and Extruded Aluminum Shapes

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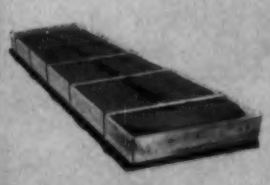

U-BEND PALLETS

This new Wolverine idea cuts time, reduces storage problems and saves money. U-Bend condenser tubes—either finned or prime surface—are arranged in a disposable box-type pallet in the exact order you specify. All you have to do is feed them directly from pallet to unit.

FIELD ENGINEERING SERVICE

This is a Wolverine "extra"—a staff of highly skilled tubing technicians ready at all times to give you experienced help in problems dealing with alloys, corrosion, design or fabrication—and at no cost to you!

PLANTS IN DETROIT, MICHIGAN, AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES.
EXPORT DEPT., 13 E. 40th St., NEW YORK 16, N.Y.

at Kilgore, Texas. Layne has been with the firm since 1934, when he started as a storeman at Healdton, Okla.

The Bristol Company has appointed S. E. **Gewin** as district manager of the company's Chicago office. Gewin's successor as manager of the St. Louis office will be **Walter Messner**. Gewin has been with the Bristol sales organization since 1937, when he became a field engineer in the Philadelphia office.

Messner has been regional field engineer in Tulsa, Okla. since 1943. He joined the Bristol sales force in 1940 in the New York office.

General Electric Company has named **A. F. Dobbrodt**, a veteran of carbide applications including engineering and sales in both metalcutting and mining operations, has been named Pacific Northwest sales representative for its Metallurgical Products department. He will make Seattle his new headquarters as of September.

Before joining the organization in 1928, Dobbrodt was superintendent of Rockwell-Barnes' Metal division. He joined General Electric as a salesman, later becoming district manager, special products development engineer and manager of mining tool sales.

General Electric Company has made **William E. Schroeder** a turbine specialist for the Southwestern district, with the home office in Dallas. The district includes Texas and Oklahoma, and parts of New Mexico, Arkansas and Louisiana. Schroeder joined General Electric Company in 1951.

Jones & Laughlin Supply Division has appointed **William M. Douglas** to its sales staff in the Tulsa general office. Douglas, formerly district sales manager of the Muskogee, Okla., district, now closed, will concentrate on petrochemical, refinery and allied industrial trade sales in the Tulsa and northern Oklahoma area. He had been at Muskogee since joining the firm in 1944, and has served in the capacities of field salesman, sales manager, and district sales manager.

Scoville Manufacturing Company has made two appointments in the newly formed Forging and Screw Machine division. **W. H. Machin** was named manager, and he has named **N. J. Schaffer** as factory superintendent of the division.

Machin has been with Scovill for 38 years. He served in the Manufacturing and Tool divisions and in 1949 was appointed tool superintendent of the Manufacturing divisions. In 1951 he was given the additional responsibility of Superintendent of Screw Machine Products division.

Schaffer joined Scovill in 1939. He was production manager of the Merchandise division and most recently production manager of the Screw Machine Products division.

Stone & Webster Service Corporation has opened an office in Houston. The Houston office would be under the direction of **Paul R. Taylor**, president of Industrial Gas Supply Corporation, Houston, who is also a vice president of Stone & Webster Service Corporation. Both organizations are subsidiaries of Stone & Webster, Inc., New York.

Suppliers . . .

Coppus Engineering Corporation, Worcester, Mass., has acquired from McRae Corporation, Glendale, Calif., exclusive manufacturing and sales rights of Sentry valves.

Sentry valves are patented automatic quick-closing latch type valves and quick-opening piston valves. Coppus becomes owner of the trademark, "Sentry." Coppus has for many years been widely known for its steam turbines, portable ventilators and fanmix gas burners.

Manufacture and distribution of the Sentry valves has been transferred to Coppus at Worcester, Mass.

The latch type valves are widely used in the chemical, petroleum and gas industries for automatic closing of gas and fuel lines.

The line addition is a further carrying out of the Coppus policy of diversification of products and markets. The new line augments its service in the power plant, petroleum and chemical fields where Coppus products have become well established.

Worthington Corporation has appointed **Lawrence P. Brady** as national account sales coordinator for air conditioning and refrigeration equipment in its New York district office. He will be responsible for sales contact work with the buying headquarters of all national accounts located in the New York territory for air conditioning their properties in other areas throughout the country. Brady has had wide experience in air conditioning and refrigeration sales with the Allan

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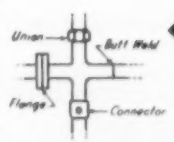
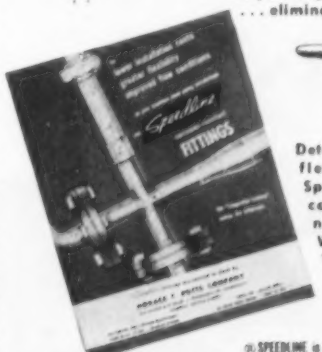


FITTING IS ADAPTABLE . . . YOU SELECT THE TYPE OF JOINT

- Simple layouts require fewer design hours
- Versatility permits reduced inventory
- Expanding feature saves time, money . . . eliminates need for costly tools



Details of the greater design flexibility possible with Speedline Fittings—at lower cost—are contained in this new illustrated catalog. Write for a copy today. There's no obligation.

® SPEEDLINE is a registered Horace T. Potts Co. trademark

Distributors are located in principal cities from coast to coast

Speedline STAINLESS STEEL FITTINGS

manufactured by HORACE T. POTTS COMPANY

566 East Erie Avenue • Philadelphia 34, Pa.

For more data on advertised products, use Readers' Service Cards, last page.

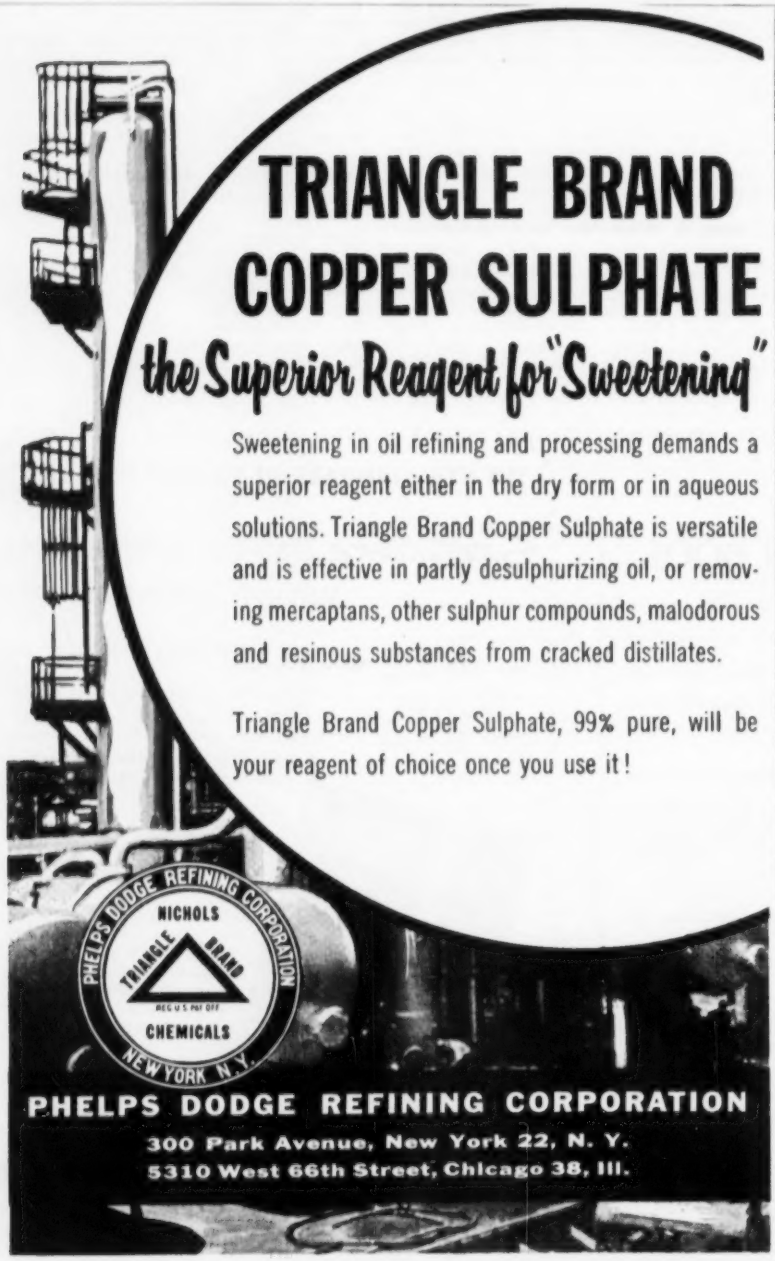
Suppliers . . .

Air Products Corporation and the Rogers Diesel and Aircraft Company where he served as vice president in charge of engineering and sales, and as manager of the air conditioning department respectively.

Selas Corporation of America has opened a new Fluid Processing division regional office in New York's Chrysler Building. The new sales and engineering activity will be headed by **Gerald E. Mitchell,** who for more than four years has been a sales representative in Selas' Newark-New York sales district. Mitchell previously has been associated with the Refractories division of Babcock & Wilcox.

Chase Brass & Copper Company has transferred **Allan R. Armstrong** from the company's Chicago office to its headquarters in Waterbury, Conn., where he will be staff manager of tube sales, a newly created position. Armstrong previously had been employed in Waterbury by Chase from 1941 to 1943 when he was a member of the Development and Sales Promotion departments. Prior to that, he had been in sales promotion in the company's Boston office, and in 1945, was transferred to Chicago as an outside salesman, the position he held at the time of his recent promotion.

Fischer & Porter Company has elected **Robert F. Lane,** assistant to the president, as a member of the company's board of directors. Lane has been with the Hatboro, Pa., manufacturer 13 years.


TRIANGLE BRAND
COPPER SULPHATE
the Superior Reagent for "Sweetening"
Sweetening in oil refining and processing demands a superior reagent either in the dry form or in aqueous solutions. Triangle Brand Copper Sulphate is versatile and is effective in partly desulphurizing oil, or removing mercaptans, other sulphur compounds, malodorous and resinous substances from cracked distillates.
Triangle Brand Copper Sulphate, 99% pure, will be your reagent of choice once you use it!
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TRIANGLE BRAND
CHEMICALS
NEW YORK N.Y.
PHELPS DODGE REFINING CORPORATION
300 Park Avenue, New York 22, N. Y.
5310 West 66th Street, Chicago 38, Ill.

General Electric Company has picked **John W. Mason,** senior advertising specialist for its Metallurgical Products division, as its new manager of advertising and sales promotion. He succeeds **C. E. St. Thomas** who was transferred from the department's Detroit headquarters to the company's Marketing Services division in New York. There, St. Thomas will handle internal and external communications activities.

A. O. Smith Corporation has announced the retirement of **John Dilot,** the company's advertising manager at its West Coast works. Dilot had been with the company 37 years. Formerly head of advertising and public-relations activities at the Milwaukee works, Dilot was transferred to the West Coast in 1952.

Weston Electric Instrument Corporation has opened a new branch sales office at 2001 South Grand in Los Angeles. Weston is a subsidiary of Daystrom, Inc. The new branch, under direct company supervision and staffed by factory-trained specialists, will serve as headquarters for instrument sales and application engineering as well as instrument field service in that area.

Olin Mathieson Chemical Corporation is cooperating in a special research program aimed at improving the quality and yield of various agricultural crops in Peru. The major centers of Peruvian agricultural research are the experiment stations at La Molina on the coast near Lima and Tingo Maria in Eastern Peru.

Olin Mathieson Chemical will cooperate with government agencies there in a series of tests concerning disease and nutritional problems affecting cotton, rubber, tea, coffee, potatoes, cacao, and pasture lands. The work will be carried out mainly by the research stations of La Molina and Tingo Maria.

Layne & Bowler, Inc., has a new advertising manager. He is **J. R. Thomas.** For the past five years, he has been an account executive specializing in trade paper and merchandising activities with an advertising agency in Memphis.

Vulcan-Cincinnati, Inc., is the new name of The Vulcan Copper & Supply Company. Under its new name, the Cincinnati firm will continue as an engineering, manufacturing and construction concern. Formed in 1903, the company is today organized into three major divisions: Vulcan Engineering division, which engineers plants and process units for the chemical and petrochemical industries; Vulcan Manufacturing division, which designs and fabricates chemical-plant equipment, and Vulcan Construction division, which serves as contractors and contract managers for plant construction, renovation and equipment installation.

Chicago Pneumatic Tool Company now has **W. S. Sease,** who was its regional sales manager in southeast Texas, filling a post as sales manager for the Oil Tool division with headquarters at its Fort Worth plant.

Mack Trucks, Inc., will acquire the truck business of Brockway Truck Company. Mack will take over all of Brockway's manufacturing, sales and service facilities under terms of a special pur-

NO.2 in a series of ALUMICOAT APPLICATIONS

RESISTS HIGH TEMPERATURE CORROSION!

Alumicoat

Molten Aluminum

PROCESS PROTECTS REFINERY EQUIPMENT

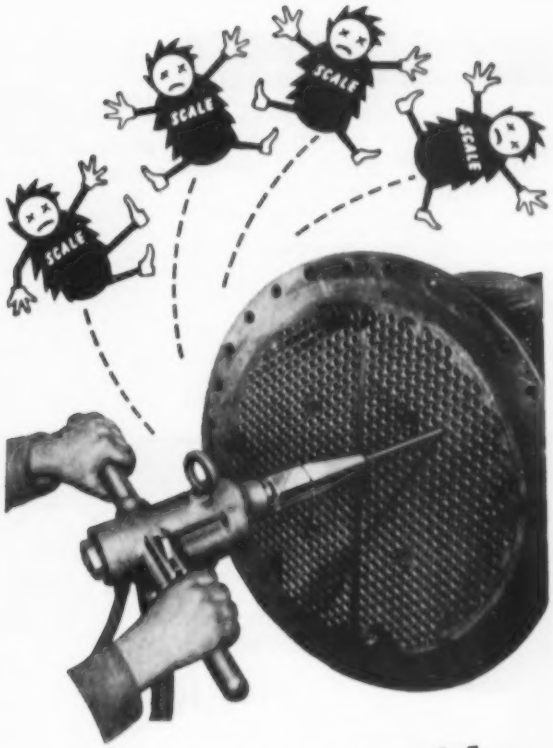
More and more refineries are discovering the advantages of the new ALUMICOAT Process! ALUMICOAT offers a firm resistance against corrosive media — *especially sulphur compounds* — and extreme temperatures!

In the ALUMICOAT Process, refinery parts are dipped in molten aluminum to produce a metallurgical iron-aluminum bond at the interface and a surface overlay of pure aluminum. At temperatures exceeding the melting point of aluminum, the aluminum on the surface diffuses. This diffused coating, together with the iron-aluminum bond, provides a refractory material that gives steel maximum protection against high temperature scaling.

The Alumicoat Process can solve your corrosion and oxidation problems. Send for full details today!

ARTHUR TICKLE ENGINEERING WORKS, INC.

26 Delevan Street MAin 5-4200 Brooklyn, N. Y.



Knock out scale with

Wilson Tube Cleaners

Are your tubes completely fouled with scale buildup? Or, are you looking for that last vital inch of heat transfer efficiency? In either case, efficient hard-working Wilson Tube Cleaners are the answer.

Wilson brings you a complete line of fast-acting tube cleaners. They handle every kind of deposit, hard or soft, thick or thin or variable in depth. Driven by air, steam, water or electricity, these powerful cleaners make quick work of cleaning straight or curved tubes.

For heavy duty service, for example, use Wilson Model TP 301 shown above. This tube cleaner is suitable for vertical or horizontal use in straight or curved tubes 3/8" ID to 2 7/8" ID and up to 40' long. Cleans rapidly, thoroughly, operating at high speed at 90 psi. Can run on pressure as low as 50 psi.

Write for your free copy of new Wilson Catalog 77. It's a mine of information on tube cleaning problems.

Representatives in principal cities

Thomas C. Wilson, Inc., 21-11 44th Ave., Long Island City 1, N.Y.

Cable address: "Tubeclean" New York

See our exhibit at the 22nd National Exposition of Power & Mechanical Engineering Coliseum, New York, November 26-30, 1956

Suppliers . . .

chase-rental agreement, and will carry on the business as a separate division of Mack Trucks, Inc.

The agreement calls for outright purchase by Mack of Brockway's inventory. In addition, the Brockway plant and manufacturing facilities at Cortland, N. Y., together with the Brockway-owned branches, will be rented by Mack with an option to purchase. Leases on presently rented branches will be assumed by Mack.

Mack will maintain the Brockway organization in its present form, operating it as a division of Mack Trucks, Inc. Mack will continue to manufacture and sell the Brockway trucks and products. Parts and service will be available through the present sales and service branches, which assures all Brockway users of continuing prompt and efficient servicing of all Brockway trucks.

Rockwell Manufacturing Company's Col. **Willard F. Rockwell,** board chairman, has been knighted by the Italian government in the order "Al Merito Della Repubblica." The coveted honor—usually reserved for Italian citizens—was conferred by Vice Counsel Carlo M. Rossi-Arnaud on behalf of the president of Italy. Dr. Rossi cited Col. Rockwell's "outstnading contributions to Italy's reconstruction and economic recovery since World War II, and his inspired efforts to promote closer economic relations between this nation and the U. S."

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REPLACES OTHER MAKES • USES REGULAR INKS
Regardless of pulsations or other causes of ink failures this new Never-Dry Pen will make clean and complete records. Ink supply lasts for several months without refilling reservoir. Capillary tube from ink bottle placed in instrument case feeds pen with continuous flow. Closed system sealed from atmosphere prevents clogging and dirt accumulation.
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Sherman Products, Inc., has appointed Burdett W. Dzendzel to the newly-created post of engineering assistant to the vice president. Before joining Sherman, Dzendzel for 10 years was product engineer with Gar Wood Industries, Inc., in Wayne, Mich. He also has been a designer with the Stinson Division of Consolidated Vultee Aircraft Corporation and layout and design engineer with the Experimental division of Bendix Aircraft Corporation.

ACF Industries, Inc., has elected Russell C. Taylor and Rudolph Furrer as members of the board. Taylor is a vice president, a director and a member of the executive committee of the American Can Company and is also a director of Republic Aviation Corporation. Furrer is vice president in charge of manufacturing and engineering of ACF Industries and president of the Nuclear Energy Products division of ACF.

Alco Products, Inc., and Power Machinery Company of Tulsa and Kansas City have appointed Power Machinery as exclusive manufacturer's agent in Oklahoma and Kansas for Alco equipment. Power Machinery Company last year was appointed by Alco exclusive agent in Kansas, Oklahoma, Texas and Louisiana for the Alco's line of fin-tube heat exchangers.

The Yale & Towne Manufacturing Company has promoted Charles E. Howard, veteran of more than 15 years experience in materials handling equipment with the company, to a newly created post of manager of attachments. In his new assignment, Howard will control the recommendation and sale of attachments for all Yale lines. He joined the organization in 1941 and worked in the Engineering department nine years. In 1950 he became asssistant sales manager of electric powered trucks, a position he held until the present promotion.

The Carpenter Steel Company has named **C. F. Boyer** special assistant to W. R. Staples, manager of sales for the Alloy Tube division. After joining the Carpenter organization in 1943, Boyer was attached to the St. Louis sales office for four years, and has been Southeastern territory sales manager for the past nine years with headquarters in Atlanta, Ga. In his new assignment, he will continue to operate from the same location.

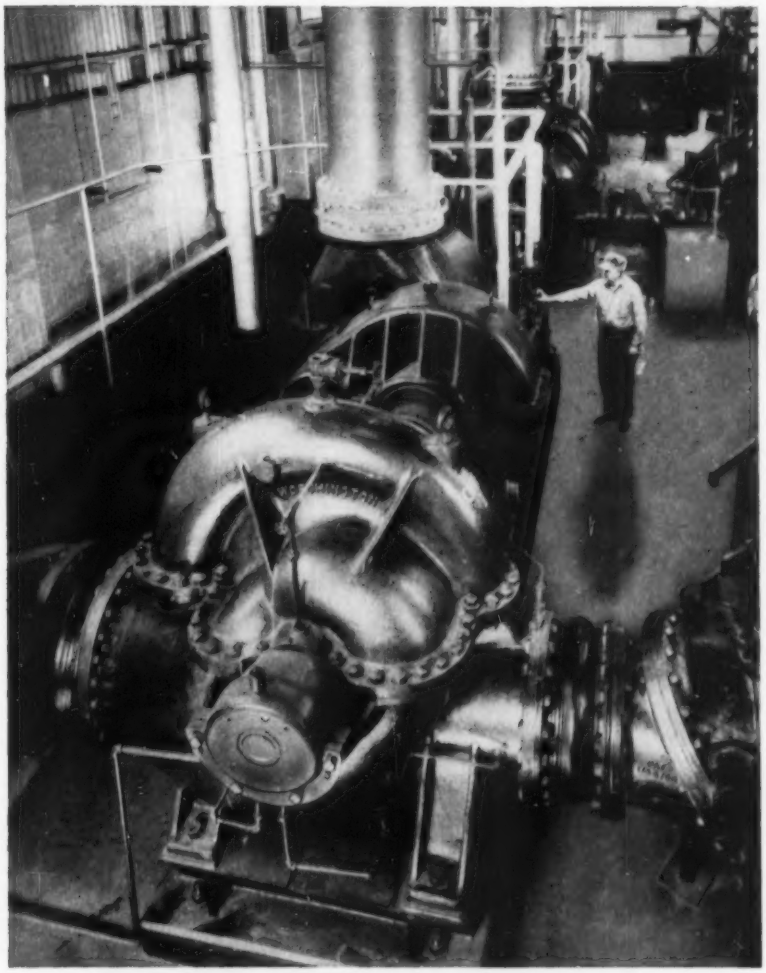
Alan Wood Steel Company plans to enlarge its Number 2 blast furnace at Swedeland, Pa., at a cost in excess of $1,500,000. Combined with another Alan Wood furnace, this new facility will give the company an annual pig iron capacity of close to 600,000 tons.

This expansion program will increase the capacity of this furnace from 550 tons per day to 800 tons per day, thereby supplying the additional tonnage of molten iron required for use in the expanded Open Hearth facilities now being constructed.

The enlargement of the No. 2 Blast Furnace is scheduled for completion by the spring of 1957. Contracts covering the work have been awarded to the Arthur G. McKee Company of Cleveland, Ohio.

Parker Appliance Company has promoted **R. D. Beatty, Jr.,** to application engineer for the Tube & Hose Fittings division in Cleveland. Beatty will specialize in instrumentation and processing applica-

For more data on advertised products, use Readers' Service Cards, last page.



Three Worthington horizontal centrifugal pumps at Gulf Coast refinery.

Gulf Coast refinery picks Worthington horizontal centrifugal water pumps

In oil refining operations you've got two strikes against you if you can't count on a dependable general water supply.

You need water for cooling towers, general service, engine and compressor cooling, heat exchangers and condensers. And water must be available 24 hours a day to eliminate costly down-time.

That's why a Gulf Coast oil company picked three Worthington turbine-driven horizontal centrifugal pumps *(above)* for water in their Texas refinery. These units operate continuously at rated capacity, head and efficiency.

The easy accessibility for inspection and maintenance, the 24-hour dependability and sustained performance of these pumps reflect Worthington's experience with refinery pumping problems.

Why a horizontal pump?

Here are five big reasons for installing a Worthington horizontal centrifugal pump:

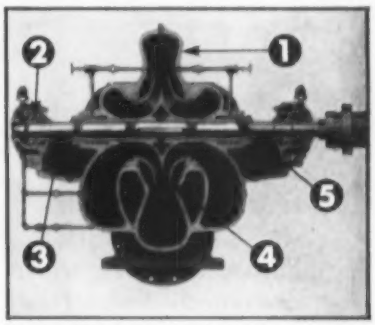
1. **Casing** — horizontally split. Upper half lifts off to allow inspection and maintenance.

2. **Bearings** — double-row ball bearings are easily accessible for servicing and replacement. Location prevents contamination from water being pumped.

3. **Shaft** — easily arranged for dual drive. Shaft may be extended opposite main drive source to accommodate any standby prime mover.

4. **Symmetrical impeller** — balanced axial forces mean negligible thrust loads for low wear, long life. High initial and sustained efficiency.

5. **Stuffing boxes** — under suction pressure and fitted with renewable shaft sleeves.



Horizontal centrifugal pump (cutaway view).

There's a Worthington horizontal centrifugal pump for every purpose. Available with casing, impeller, shaft, shaft sleeve, and wearing rings in bronze, iron or alloys for various water conditions — with standard water-sealed stuffing boxes or mechanical seals. Get all the facts on Worthington horizontal centrifugal pumps for your application — jot down your requirements on your letterhead and we'll send you bulletins on suitable pumps promptly. Write Worthington Corporation, Section C.5.1C, Harrison, N.J.

C 5.1C

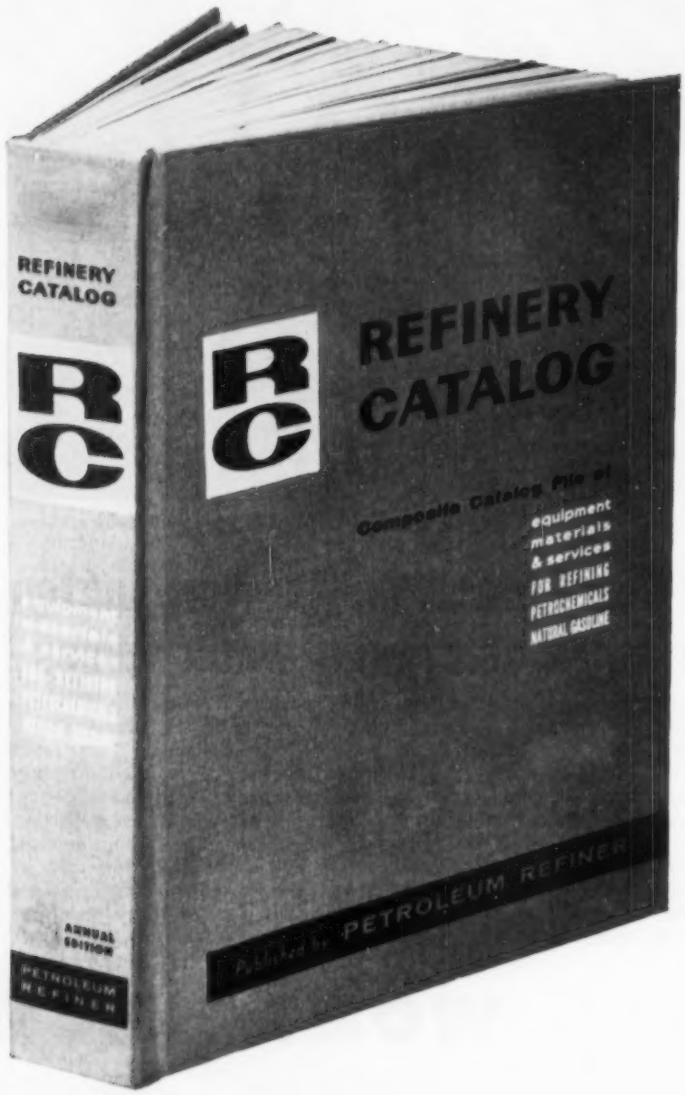
WORTHINGTON

THE WORLD'S BROADEST LINE ASSURES YOU THE RIGHT PUMP FOR EVERY JOB

CENTRIFUGAL • ROTARY • STEAM • POWER • VERTICAL TURBINE

NOW

IN "NEW DRESS"



Here's how the REFINERY CATALOG's 1956 Edition appears, with new cover design featuring a large "RC" for easy identification.

For more data on advertised products, use Readers' Service Cards, last page.

When you have to make fast, accurate buying or specifying decisions, use the REFINERY CATALOG. It is the Refining Industry's universal equipment guide . . . containing the information you need for adequate comparison on hundreds of different types of products and services.

In the new (23rd) Edition, you'll find catalog data from more than 270 companies serving this industry, authoritative specifications and data, local sources of supply . . . and a convenient index of manufacturers, equipment and services.

Remember—*it's the industry's most complete single source of equipment and service data.* Use it to help you on your job.

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MORLAND specialties

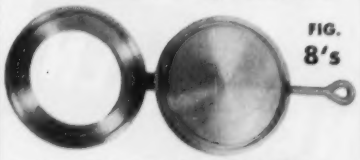


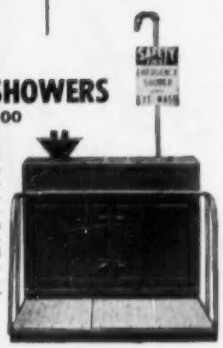
FIG. 8's

TEMP. STRAINERS

DRIP RINGS

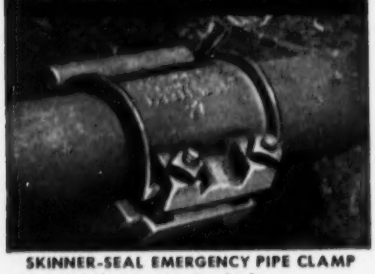
SAFETY SHOWERS
MODEL CO-100

Combination overhead shower and eye bubbler independently activated by aluminum platform treadles. Cabinet houses all piping. Steam or electric heat. Doors front or back.



MORLAND ASSOCIATES
Office and Plant
63 SOUTH AVENUE • GARWOOD, N. J.

TO REPAIR PIPE LEAKS— QUICKLY, PERMANENTLY
ANY PRESSURE — ANY TEMPERATURE



SKINNER-SEAL EMERGENCY PIPE CLAMP for pinhole or corrosion leaks.

SKINNER-SEAL PIPE LINE CLAMP for long splits and bad corrosion leaks.

In stock — all supply stores

M. B. SKINNER COMPANY
SOUTH BEND 21, INDIANA, U. S. A.

Suppliers . . .

tions, working with construction engineering and contracting firms in the chemical processing, petroleum refining, power plant and associated fields. Formerly service manager of the Industrial Hydraulics division of Parker, Beatty is succeeded in that position by **Robert C. Dyrenforth**, transferred from the division's Engineering department.

Minerals & Chemicals Corporation of America has named **C. Y. Haas** as manager of sorptive mineral sales. Haas joined Minerals & Chemicals in charge of agricultural sales and sales development in 1946. He was manager of the Technical division and subsequently assistant director of research prior to this new appointment.

Union Carbide and Carbon Corporation plans to build near Tarrytown, N. Y. Needs of the corporation require the construction of several buildings in addition to the home office building to be erected in New York. These are an office building to house the sales departments of several of the corporation's divisions; a basic research laboratory to conduct general research, and a service laboratory devoted to research work on customers' problems.

These new facilities will eventually be staffed by approximately 1,000 people, some of whom are now in the employ of the Corporation in New York and elsewhere. As plans mature, any individuals affected by this program will be advised, and in each individual case every consideration will be given to minimize any inconvenience resulting from relocation or reassignment.

This building program in Westchester in no way affects the Corporation's plans for its new home office building on Park Avenue between 47th and 48th Streets in New York City.

Fischer & Porter Company is opening a sales office in Pensacola, Fla. The new office will cover sales territory along the Gulf Coast of portions of Florida, Alabama and Mississippi, formerly handled out of New Orleans. Address of the new office is 603 Rue Max Street.

Byron Jackson Pumps, Inc., a subsidiary of Borg-Warner Corporation, has appointed **G. W. Crossman** as accountant. In his new duties, Crossman is responsible for all accounting and fiscal matters for pump products. He has been with Byron Jackson for 16 years.

U. S. Steel Corporation has appointed **Victor N. Kindjerski** as field representative at Red Deer, Alb., for the Oil Well Supply division. Kindjerski was employed by "Oilwell" in 1954 at the Wetaskiwin, Alb., store and in 1955 was transferred to Red Deer.

Chase Brass & Copper Company has named **John J. Vreeland**, previously a products control head and technical service metallurgist at the firm's Cleveland mill, to be staff manager, sheet and strip, at its Waterbury, Conn., headquarters. His experience with Chase has covered the fields of sales promotion and metallurgical engineering, both in Waterbury and at the Ohio mills.

Stauffer Chemical Company has increased the technical staff of its Richmond, Calif., plant by adding **Richard W. Davis, a chemist**, and **Fred Davenport**, a chemical engineer. Davis formerly was connected with Colgate-Palmolive as an analytical chemist and worked for Shell Oil Company. With Stauffer, he will be assigned to the control laboratory. Davenport is a recent graduate of the University of California.

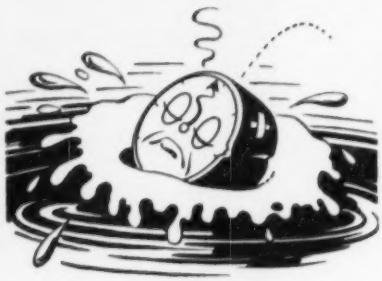
Chicago Bridge & Iron Company has announced that **Harry E. Douglass, Jr.**, who joined the Engineering department of the Birmingham, Alabama, plant in 1954, has been assigned to the firm's Chicago sales office.

Hooker Electrochemical Company has consolidated its district sales offices with the Durez Plastics division and the Niagara Alkali organization. The various sales offices of the Durez Plastics division will continue to operate as a divisional entity even though physically housed with the chemical sales offices. Headquarters sales offices for chemicals will continue to be at Niagara Falls, and for plastics at North Tonawanda, N. Y.

Adsco Industries, Inc., has named **G. H. DeKay, Jr.**, as vice president in charge of sales for its California Steel Products division. He has been serving as sales manager since January 1955. In 1947 he became associated with California Steel Products division as a sales engineer.

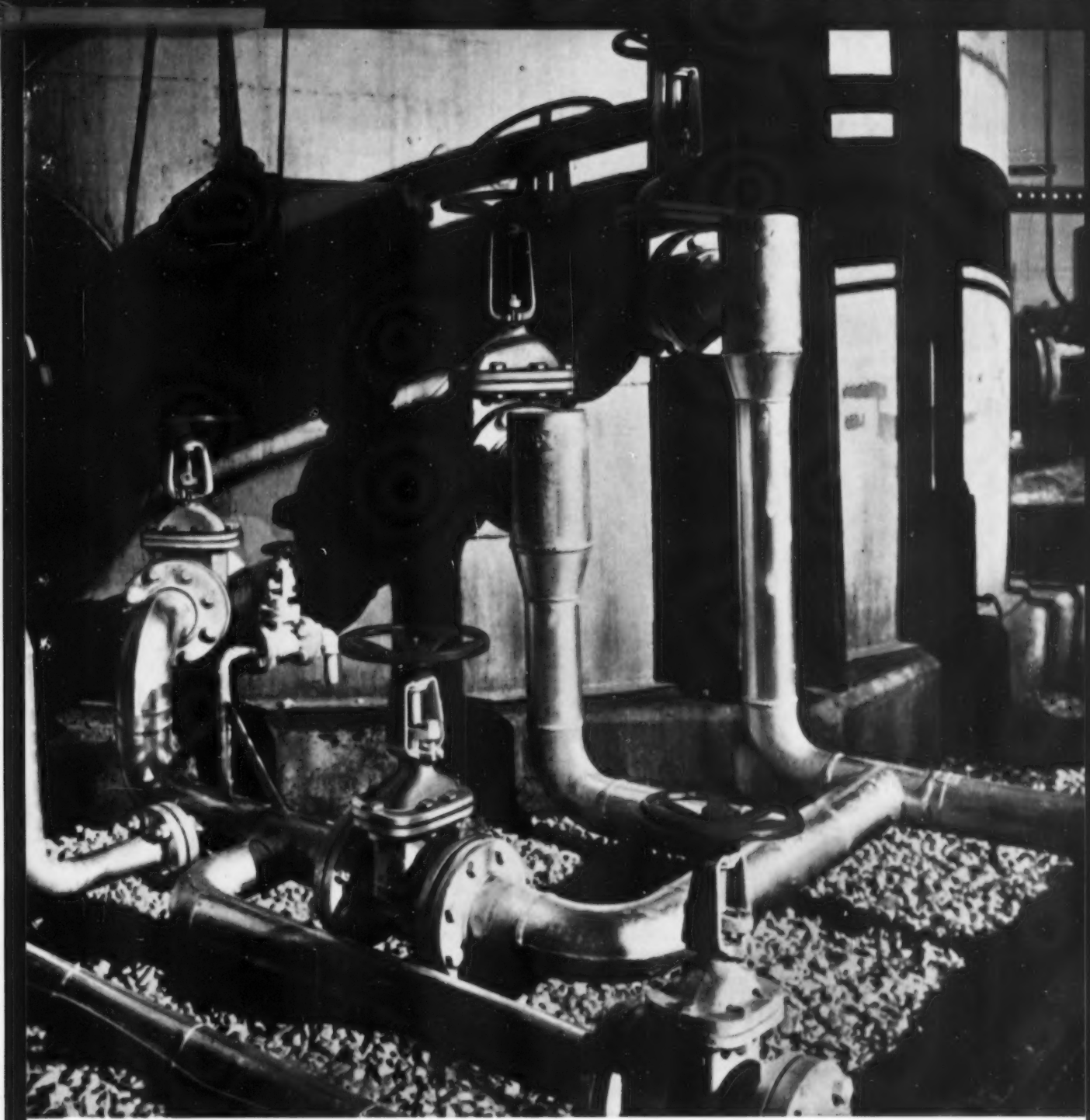
The Dow Chemical Company has promoted **Elmer K. Stilbert** to staff manager of coating materials for the Company's Plastics department. Stilbert served

OLD SLUSH POND GETTING YOUR GAUGES?
REPAIR THEM!



Throwing away worn gauges is expensive. Save ½ to ⅔ the cost of a new one with our dependable, quality repair service. All work guaranteed. Fast return.

TULSA GAUGE AND INSTRUMENT CO.
1133 N. UTICA • TULSA, OKLA.



Meet three synthetic detergent experts

You're looking at a Philadelphia installation of The Atlantic Refining Company (expert #1).

Ultrawet, an important ingredient of synthetic detergents, is the product being processed in this modern plant designed and built by The H. K. Ferguson Co. (expert #2).

Helping to prevent contamination of the product due to corrosion are long-lasting, red-wheeled valves made by Aloyco (expert #3). Made of corrosion-resistant Aloyco 20, the gate and globe valves used here handle a 98% concentration of sulfuric acid at up to 180° F.

Whatever your process, whichever corrosives you need to keep in line, it pays to check first with Aloyco. As the world's largest manufacturer of corrosion-resistant valves exclusively, we're most likely to have the valve you need. Write Alloy Steel Products Company, Inc., 1301 West Elizabeth Ave., Linden, New Jersey. 63

Subsidiary of Walworth Company

"Inside-out" Furnace Construction calls for BALDWIN-HILL dual purpose

SUPER POWERHOUSE CEMENT

B-H Super Powerhouse Cement applied over B-H Mono-Block on Riley-Stoker Pressurized Furnace at large chemical plant.

it Insulates as it Finishes . . .

- Dries fast to smooth, glazed white finish; may be painted with water or oil-base paints or weatherproofed for outdoor application.
- Does not wash off after initial set if exposed to rain before application of weatherproofing.
- Dries without shrinking; no reworking to point up shrinkage cracks.
- Easily troweled; excellent adhesive qualities prevent fall-off during application.

See our catalog in Sweet's Plant Engineering File or write for a copy.

BALDWIN-HILL COMPANY

709 Breunig Ave., Trenton 2, N. J.

Huntington, Ind. Kalamazoo, Mich. Temple, Texas

BALDWIN-HILL BH INSULATIONS

COMPLETE LINE OF BALDWIN-HILL INSULATING PRODUCTS

B-H Mono-Block	B-H Super Powerhouse Cement	B-H No. 100 Pipe Insulation
B-H Blanket	B-H No. 1 Insulating Cement	B-H 85% Magnesia Pipe Insulation
B-H Koldboard	B-H No. 52 Asbestos Cement	B-H Calcium Silicate Pipe Insulation
B-H Bond-Tite	B-H Spun Felt Insulation	B-H Mono-Kover Pipe Insulation
B-H Weatherseal	B-H Fine-Fyber Felt Insulation	B-H Spun Mineral Wool Fill

For more data on advertised products, use Readers' Service Cards, last page.

previously as assistant manager of coatings technical service.

Stilbert started with Dow in 1940 as a research chemist and was associated initially with the Cellulose Products Laboratory. For many years he has been working on the development and use of coatings in the paint, paper, textile and other fields. Becoming assistant manager of Coatings Technical Service in 1949, he continued in this capacity until taking over his new post, except for a year's assignment as manager of priorities and allocations from 1952 to 1953.

He is credited with several patents in the coatings field and is the author of a number of papers on coating materials.

Fischer & Porter Company has completed its new calibration laboratory at Hatboro, Pa. The facility is called "The Allan P. Colburn Memorial Flow Laboratory" in memory of one of the pioneers in fluids-engineering research.

Dr. Colburn, who died in February 1955, was prominent in chemical engineering and made outstanding contributions to variable-area flow metering. Fischer & Porter has used much of the basic research he performed.

The new laboratory is one of the most completely-equipped hydraulic test facilities in the U. S. It has been specifically designed for the calibration of flowmeters measuring hazardous or volatile fluids and is engineered for safety, accuracy and flexibility.

It is equipped to conduct calibrations on both a production and research basis. There are two dual calibration units using the stanpipe-weight-stand principle, with a third unit to be added later. Volumetric displacement type calibration stands as well as facilities for testing density and viscosity-measuring instruments also were installed.

Dr. Colburn was engaged in chemical engineering research for E. I. du Pont de Nemours and Company from 1929 to 1938. Before that he was chairman of the Chemical Engineering department at the University of Delaware. During World War II, he was instrumental in directing the use of the chemical-engineering facilities at the University of Delaware on war research programs for the National Defense Research committee, the National Advisory Committee for Aeronautics, Office of Rubber Reserve and various war industries.

Chicago Pneumatic Tool Company has named **Gary A. May** general manager of the company's Oil Tool division with plant and sales offices in Fort Worth, Texas. May was employed as a student engineer in 1940 at the company's Cleveland plant. After serving as a field and plant engineer and assistant to the Rotary Tool division manager, he was appointed assistant manager of the Utica plant in 1952.

Thermoid Company has opened a new warehouse at 5978 Armour Drive in Houston. The new operation, which will be managed by **W. N. Jordan** under the direct supervision of **Norris B. Green,** Thermoid district manager, replaces facilities formerly located at 14 Kendall Street, Houston. The Houston unit is the seventh in a series of new regional warehouses that Thermoid has opened during the past year.

Jones & Laughlin Supply Division has appointed seven men to key positions at J&L store points in five sales districts.

C. W. Moore, formerly a salesman in the West Texas district, has been appointed supervisor of store construction and maintenance for the Supply Division. He will continue to maintain office headquarters in Odessa, Texas.

Ben E. Irby has been advanced from storeman to local store manager at Gladewater, Texas, in the East Texas district.

In the Louisiana Gulf Coast district, **Bill E. Trisler,** formerly manager of the Lake Charles store, has been assigned to the division's newly-constructed store at Morgan City, La., as local store manager. Succeeding Trisler at Lake Charles is **Vincent P. Panepinto,** formerly a storeman at Harvey, La.

In the South Rocky Mountain district, **Marion D. McAfee,** formerly a storeman, and **Curtis L. Sample,** formerly a salesman, have been promoted to local store managers at Sterling, Colo., and Casper, Wyo., respectively.

Suppliers . . .

Billy J. Cox has been made local store manager at Estevan, Sask., in the firm's Canadian Eastern district. Cox was formerly storeman at Anson, Texas.

Hills-McCanna Company has selected Rittelmeyer & Company, Inc., as its sales representative in Georgia and eastern Tennessee.

Rittelmeyer & Company is headquartered in Atlanta.

Rockwell Manufacturing Company President **Willard F. Rockell, Jr.** has been named co-chairman of a special 14-member committee appointed by Pennsylvania

"Alamask"

offers a complete and diversified line of reodorants for petroleum and allied products

No longer need the products of the petroleum industry inflict upon their users the obnoxious odors resulting from the mercaptans and sulfides in their processing.

Years of development work and product-testing have culminated in a complete line of Alamask® reodorants that can successfully mask the objectionable odors of many petroleum products. Check this table to see which Alamask reodorants will solve your malodor problems:

"ALAMASK"	GASOLINE FRACTIONS	ASPHALTIC COMPOUNDS	KEROSENE BLENDS	COAL SPRAY OILS	SPACE HEATERS	CUTTING OILS	CLUTCH OILS	DIESEL FUELS	JET FLUIDS	MINERAL SPIRITS	WAXES	NAPHTHA	BURNER OILS
AAM								X					
AO						X	X						
AR		X								X			
BGM		X											
BN						X	X						X
BUL				X	X			X			X		X
CC			X							X			
CE			X							X			
CX											X		
MS			X							X	X	X	X
0.19	X				X	X	X		X				X
0.20	X				X	X	X		X				X
TO									X				

Rhodia's chemists and engineers, experienced in odor abatement and waste disposal, will provide technical assistance to you in your efforts to correct malodors.

For complete information on these new, highly-effective reodorants, write today to Rhodia, Inc., Industrial Reodorants ("Alamask") Division, 60 East 56th Street, New York 22, N. Y.

Rhodia INC. 60 East 56th Street, New York 22, N. Y.

Philadelphia • Cincinnati • Chicago • Los Angeles • Canada: Haugatuck, Montreal • Cuba: Luis Felipe, Havana • Mexico: Comerciale Roka, Mexico City

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HIGH PRESSURE GLASSES and GASKETS

MAGNIFYING RED LINE

All sizes to fit your gages and valves

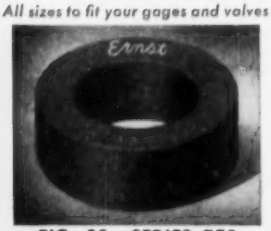


FIG. 22 SERIES 750

FIG. 21 LIP-MOLD

STATE YOUR REQUIREMENTS

All shipments from stock.
Send for Catalog

ERNST WATER COLUMN & GAGE CO.
Livingston 6-1400 LIVINGSTON, N. J.

SPECTACLE BLINDS
By MAC-IRON

Skillfully machined from mild carbon steel, fire box quality, chrome-nickel, and other alloys.

Estab. 1901

MAC-IRON Blinds, Spectacle Blinds, and Spacer Rings are available in all pipe sizes and pressure ratings for use with flat, raised face, and ring joint types of flanges. Precision machined from the particular metal needed, they can be supplied, if desired, with phonographic serrated surfaces.

MAC-IRON also offers a complete listing of line and temporary strainers. The latter of woven wire, perforated basket and conical . . . all for use with raised face, and ring joint flanges. A large stock on hand is maintained; special strainers made to specification.

Accuracy of design and construction is assurance of dependable service from all MAC-IRON products.

WRITE DIRECT FOR COMPLETE INFORMATION

The Mack Iron Works Company

Warren and Water Sts. Sandusky, O.

Suppliers . . .

Governor George M. Leader to work out a solution for that state's increasingly serious financial problems. Rockwell and Thomas Kennedy, vice-president of the United Mine Workers of America and former lieutenant governor of Pennsylvania, were named co-chairmen at a meeting called by Governor Leader in Harrisburg.

The non-partisan committee includes two Pennsylvania mayors, four labor leaders, two legislators, and six industrialists —including Pittsburghers Benjamin F. Fairless, former board chairman of U. S. Steel Corporation, and George H. Love, president of Pittsburgh Consolidation Coal Company.

Created as an emergency measure, the new Committee will seek to "construct an adequate and equitable financial base for the Commonwealth," Governor Leader said.

Western Supply Company has appointed **T. Deal Reese** as its special representative to the process industries. His duties will include special assignments in expanding the Tulsa concern's coverage in the Houston area, with particular emphasis on the refining, petrochemical, chemical and pipe-line industries. Reese previously had been with Gulf Supply Company, Inc., in Beaumont, as vice president and regional sales manager. He had been with the company since it opened its Houston office in 1947. He was elected to the board of directors a year later, made district sales manager in 1951, and elected vice president in 1954.

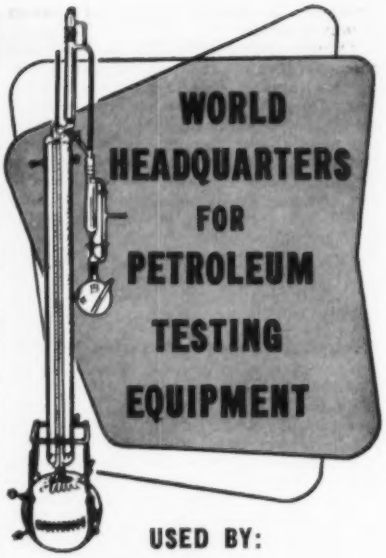
Reese

Harry Clow Boardman, who was director of research for Chicago Bridge & Iron Company, died August 6 in Chicago. He was 69-years-old. From 1910 to 1916 and since 1926 he had been with the company.

The International Nickel Company, Inc., now has **John S. Pettibone** as a member of the Corrosion section at its Bayonne, N. J., research laboratory. He will be associated with the section both as a technical writer and as a research chemist.

Prior to joining Inco, Pettibone served seven years as an assistant technical secretary with the American Society for Testing Materials. Previously, following brief periods as metallographer for Riverside Metal Company and in the Research and Development Department of The Atlantic Refining Company.

Kaiser Steel Corporation has made Harrison H. Hance advertising manager. He also will be in charge of publications issued from the company's home offices in Oakland. Hance joined Kaiser Steel in 1954 as administrative assistant to the vice president, in charge of advertising and publications. Before that, he was with Kaiser Services for six years, last serving as assistant to the manager,



USED BY:

- **REFINERIES**
- **GASOLINE PLANTS**
- **PETROCHEMICAL PLANTS**

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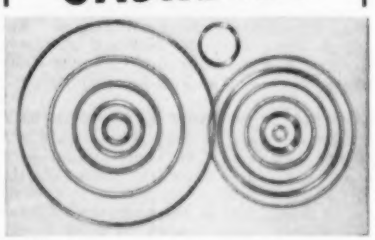

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Since 1906, Chicago-Wilcox has served the refining industry with gaskets for every requirement. These A.P.I. ring gaskets are typical. Used on ring-type flanged joints in high pressure lines. Made of soft iron, standard steel alloys or any of the non-ferrous metals to any desired cross section.

Send specifications for quotations and prompt-delivery schedule.

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7703 Avalon Avenue, Chicago 19, Ill.
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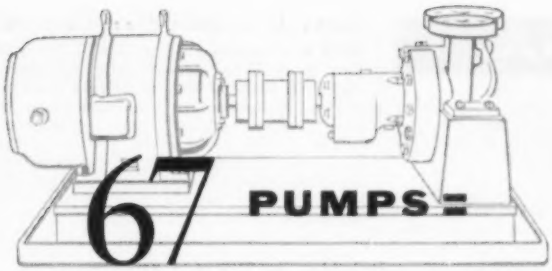
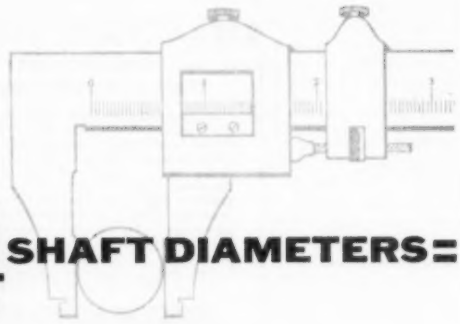
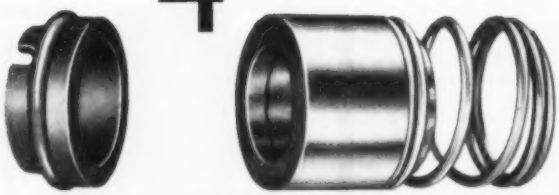


67 PUMPS=



14 SHAFT DIAMETERS=

4 SEALS



SEALOL FLEXIBOX BALANCED SEALS REDUCE INVENTORIES

4 TO 1!!

- A recent refinery survey revealed that 67 pumps involving *14* shaft diameters required only four sizes of SEALOL Flexibox Balanced Pressure Seals.

THIS MEANS:

Fewer parts for 100% protection.
Maintenance and stocking procedures simplified by minimum parts handling.

- SEALOL Flexibox Balanced Seals come in only twenty-one standard sizes to fit all shafts with diameters from ¾" to 4¼". Teflon ® or O ring equipped seal components are dimensionally interchangeable.
- Send for your SEALOL Sealector which will enable you to properly survey your own operation!!

SEALOL CORP.
185 POST ROAD, PROVIDENCE 5, R. I.

Baton Rouge • Chicago • Cleveland • Corpus Christi • Houston • Los Angeles • New Orleans • New York • Philadelphia • San Francisco • St. Louis • Toronto and Montreal, Canada • Flexibox Ltd., Manchester (Eng.) • Paris • Frankfurt

SEALOL

THE ▲ BALANCED PRESSURE SEAL

So SIMPLE
We Can
Adapt It
to ANY
LIQUID LEVEL
CONTROL JOB
A sleeve, raised and lowered within a non-magnetic tube, attracts or releases an Alnico magnet attached to a mercury switch. Basically, this is Magnetrol.

MAGNETROL

AS DEPENDABLE AS MAGNETIC FORCE ITSELF

● No matter how specialized the liquid level control application, adapting Magnetrol to meet it presents no problem. Whether it's for high pressures, high temperatures, corrosive liquids or any other condition, a few "standard" modifications and the job is done! Operation is so simple no changes in basic design are needed. That's why Magnetrol "fits" practically any application — why "specials" are so often standard with us.

Because of the utter simplicity and dependability of its magnetic principle, Magnetrol has *infinite operating life.* There are no wearing parts to get out of order.

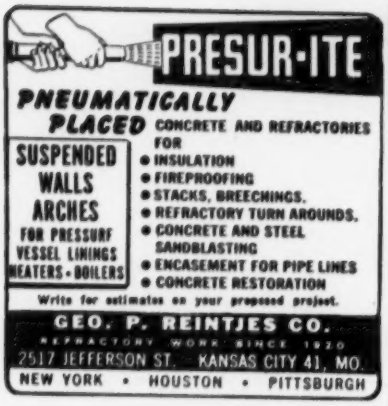
Magnetrols are available for controlling level changes from .0025-in. to 150-ft., with single or multi-stage switching. Our experienced engineering staff is at your service.

MAGNETROL, Inc.

WHY NOT MAIL THE COUPON — NOW

Magnetrol, Inc., 2112 S. Marshall Blvd., Chicago 23, Illinois
Please send me catalog data and full information on Magnetrol Liquid Level Controls.
Name_____
Company_____
Address_____
City_____ Zone____ State____

For more data on advertised products, use Readers' Service Cards, last page.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WAX PRESS FILTER BLANKETS

- Made only of first grade hydraulic press 12/0 duck
- Fabricated to your specifications
- Priced to save you money
- Cuproammonium treated

Write today for the Schotco story

SCHOTT BROS. CO. INC.
WEST SALEM, OHIO

Suppliers . . .

public relations and advertising. Other duties with Kaiser Services included that of publications manager, and managing editor, Kaiser Publications.

Wagner Electric Corporation has named **Russell E. Bryant** to manage the Electric division of its Los Angeles branch. He succeeds **Leonard G. Tandberg** who is retiring after nearly 47 years with the company. Bryant joined Wagner in 1940 as a student engineer. He was a sales engineer in the Wagner Pittsburgh office from 1942 to 1949 and for the past seven years has been manager of the company's Buffalo sales and service branch.

Plicoflex, Inc., has elected **L. L. Whiteneck** as vice president and appointed him director of corrosion control and material research. His experience includes water works design and construction for the Metropolitan Water district of Southern California and design and mine development engineer for gold mining companies in the Philippines. For the past ten years, he has been senior harbor engineer for the Long Beach Harbor department, in charge of testing and evaluation of coating materials and the economics of corrosion design.

Johns-Manville Corporation has appointed **James G. Walker** as Northeastern regional sales manager for the Johns-Manville Pipe division. Walker succeeds **Charles T. Dearborn** at Boston, who retires after a 39-year career with Johns-Manville. The Northeastern Regional Sales Office will be transferred to New York City. At the same time the appointment was made of **Charles G. Topping** to succeed Walker as New York area sales manager for the J-M Pipe division.

Tube Turns of Canada, Ltd., has bought a modern one-floor type plant at 21 York Street, Ridgetown, Ont. It is served by major railroads and all trans-Canada truck lines. Production facilities have been moved from nearby Chatham, Ont. Manager **J. A. Battist** and most of the 40 employes were transferred to Ridgetown.

Pacific Pumps, Inc., has opened a new plunger-pump store in Kimball, Neb. This store, located at 604 South Nadine Street, will furnish pumps, parts and service for the Denver-Julesburg Basin area. **Charles L. Rosenlieb,** formerly Pacific field salesman at Great Bend, Kansas, has been appointed manager of the new Kimball store.

Pacific Pumps, Inc., has also announced the appointment of **J. W. Harris** as development and research engineer for API equipment at the firm's headquarters in Huntington Park, Calif. Harris, who has been associated with Pacific more than 12 years, has just completed a two-year research program for Dresser Industries, Inc., the parent corporation of Pacific Pumps.

Catalytic Construction Company now has Mr. **Willis F. Sims** as refinery sales representative for its Southwest area, with headquarters in Tulsa, Oklahoma. Sims formerly was refinery manager at Wichita Falls, Texas, for Panhandle Oil Corporation and was associated with Blaw Knox Company before joining Catalytic.

Jones & Laughlin Steel Corporation's chairman of the board, **Admiral Ben Moreell,** has been selected to receive the John Fritz Medal. In World War II, he was the organizer and commander of the Navy's "Seabees."

The award is sponsored jointly by the American Society of Civil Engineers, the American Institute of Mining, Metallurgical and Petroleum Engineers, The American Society of Mechanical Engineers and the American Institute of Electrical Engineers. It will be presented to Admiral

(Continued on Page 505)

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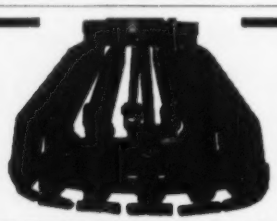

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For work in Tulsa, Oklahoma. Minimum requirements: B.S. degree in chemical or refinery engineering. Three (3) or more years' experience in Process Design work relating to Chemical Plant and/or Petroleum Refinery Engineering and Construction.

Write to Glenn O. Hopkins, Personnel Manager,

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Recognizing the need for the professional growth of the individual engineer, Kellogg provides a variety of stimulating assignments and encourages membership in engineering societies and associations. As a result, the company has grown steadily for 55 years to become a world-wide leader in the petroleum and chemical plant field. The most modern facilities are available in a brand new air-conditioned building, centrally located convenient to transportation serving suburban residential areas.

Please send resumes, including salary requirements, to R. L. Stacom. All inquiries in confidence.

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For more data on advertised products, use Readers' Service Cards, last page.

HELP WANTED

■ The Air Technical Intelligence Center has reported immediate position openings for petroleum fuels and lubricants engineers at salaries to $8990 per annum. The positions stress the ability to evaluate petroleum refining processes; to construct flow charts and material balances. The applicant must be familiar with the chemistry of petroleum process as well as the construction and design of refinery facilities. Those with knowledge of foreign languages will be given additional consideration. Applications should be addressed to: Commander, Air Technical Intelligence Center, ATTN: AFOIN-4X2b, Wright-Patterson Air Force Base, Ohio.

HELP WANTED

■ PROCESS ENGINEER: To assist Sales Department of expanding independent oil company with wide variety of petroleum problems. Primary emphasis on crude and refined product quality evaluations for foreign markets. Require resourceful young man with 3-5 years refinery experience. Location San Francisco with infrequent short trips to Europe and Asia. Please submit experience and salary resume. Confidential. Box 242-R, PETROLEUM REFINER, Houston, Texas.

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Challenging opportunity for graduate chemical or mechanical engineer with minimum five years petroleum refining experience, preferably with contracting engineering firm.

Please airmail confidential verifiable chronological resume, including salary history, to

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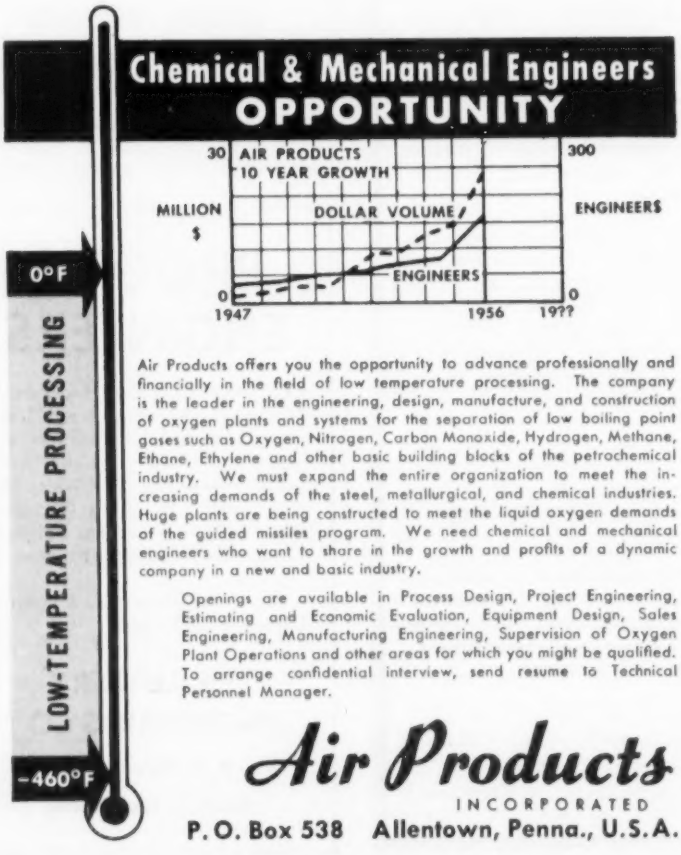
Chemical & Mechanical Engineers OPPORTUNITY



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Air Products
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Suppliers . . .

Morcell October 17 at the national convention of the American Society of Civil Engineers in Pittsburgh.

Admiral Morcell was selected as a "distinguished engineer and noted officer; builder of naval works in war, and in peace eminent industrialist and civic leader."

Previous medalists have included Bell, Edison, Goethals, Orville Wright, Marconi, Sperry, Herbert Hoover, Sr., Pupin, Kettering, Bush, Lord Kelvin, Alfred Noble, Budd, Fairless and others.

Fischer & Porter Company now has **William C. Abbey** as a district sales engineer in the Data Reduction and Automation division. After training at the company's main plant in Hatboro, Pa., he will join the sales staff in the Houston office, to cover several Southwestern states. He formerly was with Manning, Maxwell and Moore.

Southwestern Engineering Company has appointed **Philip Frenеau** to the newly-created position of chief project engineer for the company's Manufacturing division. He joins the company after ten years with Elliott Company at Jeannette, Pa. He recently had served as chief engineer of the company's General Apparatus division.

Worthington Corporation has selected **Arthur R. Foreman** as Comptroller of the Steam Turbine division at Wellsville, N. Y. He replaces the late **Carl R. Gavitt.** Foreman joined Worthington's

(Continued on Page 506)

HELP WANTED

Sales Engineer

Manufacturers representative requires young chemical or mechanical engineer with process experience to sell process equipment to Gulf Coast Refineries and chemical plants. Participate substantially in steady growth of small company. Replies confidential. Give short resume for interview.

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Liberal all-inclusive benefits. Opportunity to travel on long vacations and live in modern community with complete facilities including extensive recreation.

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HELP WANTED

PROCESS ENGINEERS with Eight or More Years Experience

Our Process Engineering Department has opportunities for several experienced engineers who wish to follow their preferred fields in petroleum refining or large volume petrochemical processing.

Assignments will be primarily process design and economics — determination of overall process requirements, selection of processing steps, and economic evaluation of processes. Other work may include market analysis, industrial surveys, and technical assistance to sales.

Write to the head of our Personnel Department, Mr F B Stratford.

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HELP WANTED

CHEMICAL ENGINEER WANTED

Progressive company with excellent working conditions needs graduate chemical engineer with some experience in stabilization, dehydration, etc., who can evaluate results of outside consulting information. Opportunity for right man to progress rapidly. Start $8400 up.

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For more data on advertised products, use Readers' Service Cards, last page.

Suppliers . . .

Wellsville division in 1951, and he served successively as priority supervisor, assistant purchasing agent and internal auditor prior to his present appointment.

Electro-Technical Labs has begun construction on a $335,000 building for new quarters. The offices and plant will be of modern design and air conditioned throughout, located in Houston near Bellaire. A two story office containing 13,375 square feet of floor space will be devoted to offices, accounting department, sales and engineering departments. A one story plant of 16,750 square feet will house the assembly and machine shops.

Western Supply Company, or a majority stock interest in the company, has been sold to three oil-industry figures. They are **W. A. Baden,** president of Anchor Petroleum Company; **B. B. Blair,** independent oil man, and **L. F. Rooney,** Muskogee and Tulsa industrialist. The company will continue to be operated by its present personnel, and **F. Wilson Dye,** who was president before the company was purchased, will act as chairman of

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PIPING ENGINEERS

Qualified piping engineers and designers, preferably with 5 years experience or more, can broaden their professional responsibilities with C F Braun & Co. The work is on engineering and design of complete integrated petroleum refineries and petrochemical plants, many types of individual process units, and power plants.

Assignments include arrangement of plant equipment and facilities, layout of process and utilities piping, stress analysis of piping systems, design of spring supports, and preparation of specifications for piping materials and insulation.

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Major Oil Company has openings for Chemical, Mechanical, Electrical and Civil Engineers in several phases of refinery engineering and process engineering. Locations near New Orleans and south Arkansas, in booming industrial areas where climate and natural advantages make living more enjoyable for all the family. Attractive salary and benefits program. In reply give age, education, experience and salary expected. Pan-Am Southern Corporation, P. O. Box 2, New Orleans 6, Louisiana.

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Telephone TOwer 1-2300, Cleveland, Ohio
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There are outstanding career opportunities with one of the 100 largest corporations in the United States for men with the following qualifications:

- One to five years experience in petroleum refining or related activities.
- B.S. or higher degree and experience:
  (Chemical) in development, pilot plant operation, process design, process trouble shooting, refinery process engineering, economic studies or related work.
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- Age range . . . 22-32.

Choice positions open in Cleveland, Toledo and Lima, Ohio.

Write, giving a complete resume of your education, experience and personal data to:

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1737-F Midland Building, Cleveland 15, Ohio

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With three to six years experience

Several qualified process engineers can broaden their professional responsibilities in our Process Engineering Department. They will design a wide variety of plants for petroleum refining and large volume petrochemical processing.

Assignments range from complete integrated refineries and chemical plants through all types of individual process units. The work includes heat and material balances, and computations for unit operations such as fractionation, heat-transfer, absorption and extraction.

Fine facilities, top salaries, new retirement plan. Write to the head of our Personnel Department, Mr F B Stratford.

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POSITIONS WANTED

■ CHEMICAL ENGINEER, B.Sc.Ch.E. '42, equal knowledge of English and German; Experience: 9 years research and development oil and gas processing, 5 years process and job engineer for oil refineries. Desires European assignment as process, project or sales engineer. Box 240-R, PETROLEUM REFINER, Houston, Texas.

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■ LUBOIL PLANT. Wanted second hand in good condition with Vacuum Dest., Solvent Extraction, MEK Dewaxing, Continuous Treating and Barrel Filling. Intake Capacity 1000 bbl/day. Bids under box number 237-R, PETROLEUM REFINER, Houston, Texas.

FOR SALE

the board and chief executive officer. Other officers are **James E. Hughes,** vice president of the Heat Exchanger division; **Mylon C. Jacobs,** vice president of the Supply division, and John D. Miller, secretary-treasurer.

Olin Mathieson Chemical Corporation has designated **Earle R. Van Vliet** as treasurer. He had been assistant treasurer. Van Vliet succeeds **E. W. Taft** who retires after 40 years with the company. Van Vliet joined E. R. Squibb & Sons in 1946 as vice president and treasurer, leaving Tubize Rayon Company where he was executive vice president and chief financial officer. When Squibb joined Mathieson Chemical Corporation, Van Vliet was made vice president and treasurer of Mathieson.

Taft began his career in the engineering department of the Winchester Repeating Arms Company in 1916. In 1943, he was named treasurer of the then Olin Industries and, after the merger of Olin Industries, Inc. and Mathieson Chemical Corporation in September 1954, was named treasurer of Olin Mathieson Chemical Corporation.

J. F. Pritchard & Company has appointed **Dayrel G. Hoke** as sales engineer in its New York district office. Prior to joining Pritchard, Hoke was a sales engineer for the Kewanee Boiler Corporation in Philadelphia.

Conoflow Corporation has Chemical & Industrial Sales, Ltd., Edmonton, Canada, sales-engineering representative. Ciscan will handle the provinces of Alberta and Saskatchewan. Principals of Ciscan, founded in 1955, are **John C. Hamon** and **James E. Wiltshire.** Both men are well known in the instrumentation and controls field in Canada. Hamon possesses almost 20 years of experience gained through association with Foxboro, Abitibi, Imperial Oil, Dow Chemical, and Celanese Corporation. Wiltshire was with Minneapolis-Honeywell, Toronto, for 12 years.

U. S. Rubber Company has elected **Howard N. Hawkes** a member of the board of directors and member of the executive committee. He is a vice president of the company. At the same time,

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Suppliers . . .

G. Raymond Cuthbertson was elected a vice president and named general manager of the Tire division succeeding Hawkes.

Hawkes started with the rubber company in 1912 and was appointed general sales manager for the Tire division in 1934, assistant general manager of the Tire division in 1944 and vice president and general manager of the division in 1951.

Cuthbertson joined U. S. Rubber in 1936 as a research chemist. He has since been assistant director of tire development in Detroit, factory manager in Los Angeles and production manager for the Tire division at its general offices in New York. He was named assistant general manager of the Tire division in January, 1956.

Hes

Panich

Bailey Meter Company has appointed **Cornelius J. Hes** and **Michael Panich** assistant managers to **T. A. Green,** manager of the Design department. The department has been divided into two groups with Hes in charge of special design and Panich in charge of product design. Hes joined Bailey Meter as a draftsman in 1927; Panich started with the company as a draftsman in 1940.

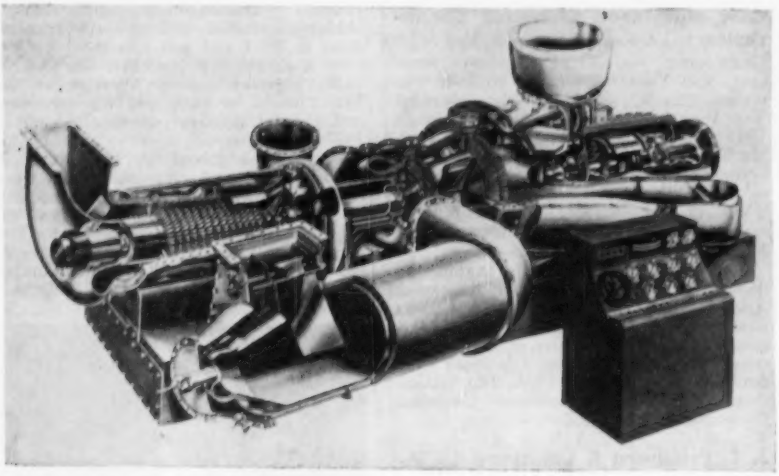
Hooker Electrochemical Company and Oldbury Electro-Chemical Company, both of Niagara Falls, are negotiating for a merger of Oldbury Electro-Chemical into Hooker Electrochemical. Should the current negotiations result in an agreement approved by the boards of both companies, it is anticipated that the proposal will be submitted to the stockholders of both companies at special meetings this fall.

Titeflex, Inc., has completed the consolidation of its facilities at Springfield, Mass. This consolidation, a $1,500,000 operation, was accomplished to take full advantage of the economies and efficiency derived from the operation of one plant. The Springfield plant was selected because of its layout for efficient manufacturing, and for space in which to expand. The plant now comprises over approximately 300,000 square feet, having been enlarged by 40,000 square feet during the consolidation. There remains approximately 16 acres for further contemplated expansion.

Ethyl Corporation has named **Norman J. Linstromberg** as district manager of its Dayton office. He succeeds Robert R. Mead, who is on special assignment at the company's Central region headquarters in Chicago. Linstromberg has been associated with Ethyl since 1941. Prior to his present promotion, he was a sales representative in Kentucky.

For more data on advertised products, use Readers' Service Cards, last page.

What's New in Equipment . . .



Ruston Mark TA Gas Turbine—Light weight, compactness, air cooling, fuel flexibility, ruggedness and long life are features of the Mark TA gas turbine. Clark Bros. Company, one of the Dresser Industries, has completed an agreement with Ruston-Hornsby Ltd., Lincoln, England, for the manufacture and sale of the Ruston Mark TA gas turbine in this country.

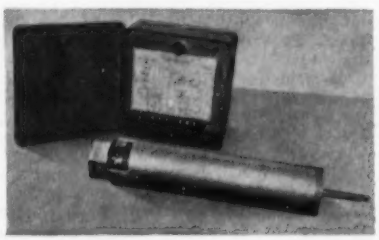
This prime mover is especially suited to processes where power is required and where the exhaust energy can be used for preheating or for the generation of steam. The turbine develops 1130 BHP at 80 degrees and 1,000 ft. The nominal low pressure or output turbine speed is 6,000 rpm. Output speeds of 1,500 and 1,800 rpm are available for driving 50 or 60 cycle generators through the use of built-in planetary gears. Clark Bros. Company.

Circle E1 on the card.

Solderless Sight Glass—Sight glasses which require neither solder nor gaskets, thus eliminating the main sight glass failure points, are now being made. A new manufacturing process makes possible a long-wearing unit in which the glass is hermetically sealed directly to metal.

Pressure resistance of the windows is dependent on the size and shape of the individual unit. One design ⅜-inch in diameter and ⅛-inch in thickness withstands pressures in excess of 5,000 psi. Another assembly ¾-inches in diameter and ⅛-inch thick operates at 2,000 psi. The windows show no leaks when tested on a helium leak detector at maximum sensitivity. Corning Glass Works.

Circle E2 on the card.



Submersible Motor—A completely submersible explosion-proof pump motor is now being produced. The new motor was designed to overcome vapor-lock problems generally associated with positive displacement suction pumping systems. The increased use of higher-octane, more volatile fuels has greatly intensified vapor-lock difficulties, particularly in installations operating in warmer areas or at higher altitudes.

The submersible pump motor installs directly in existing gasoline storage tanks with 3½-inch standard pipe flanges. Gasoline flows between the stator and outer shell for maximum cooling of the motor. A small amount of gasoline also passes within the motor itself, providing bearing lubrication and additional cooling.

Gasoline can pass directly through the motor because the stator is completely sealed in an epoxy resin especially formulated for use in gasoline and other solvents.

A remote control box supplied with each submersible motor includes the overload, starting and control circuits packaged as a compact, removable assembly. Leland Electric Company, Division of American Machine and Foundry Company.

Circle E3 on the card.

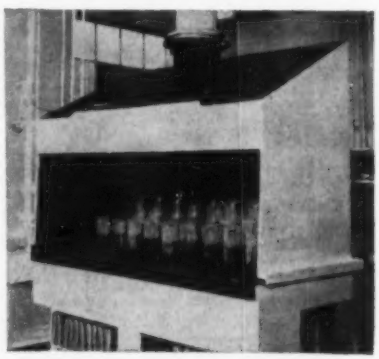
Liquid Neoprene—Neoprene is a magic word representing a new type of synthetic rubber made by Du Pont for providing high resistance to many organic and inorganic chemicals. Now, for the first time, it is possible to supply essentially the same Neoprene coating in a liquid form suitable for brushing or spraying without the concern heretofore necessary of watching the shelf-life of the liquid product.

For years, Neoprene has been accepted by chemical engineers as the ideal rubber protective coating against acids, caustics and solvents. Now the protective features of Neoprene are available in a practical, brushable film, applicable to structural steel shapes, pipes, and irregular areas.

Rubber-Coat liquid Neoprene will fill a long felt want in industry and can be used in many instances where other paint products fail. It will find a ready use in the painting of air-conditioning equipment, louvers, and cooling towers—concrete foundations and caissons in fresh or salt water—exteriors of tanks, trucks, and railroad tank cars used for hauling various corrosive chemicals and solvents—canvas roofs of trucks and canvas decks—food equipment — marine equipment — roofs, where it may be also used to touch up and seal down asphalt shingles which may have come loose—to patch and repair canvas belting and rubber hose—as a dip to provide non-slip handles on tools, etc.—wherever oil or gasoline fumes are a problem. It is available in black, red, light gray and aluminum. The Wilbur and Williams Company.

Circle E4 on the card.

Plastic Fume Hood—This laboratory fume hood is one of many different sizes and shapes being offered to provide resistance to corrosion from a wide variety of acids (including even hydroflouric in some materials) salts, alkalies, alcohols, esters, ethers, and hydrocarbons. As part of complete fume duct systems made entirely of plastic, these hoods and reaction cabinets offer service far superior to galvanized or black iron and in many uses superior even to stainless steel often at substantially lower cost. These hoods are offered in a variety of standard and special sizes with fume ducts and exhaust systems made up of standard size duct and fittings to meet virtually any condition. Bifurcator housings, also of corrosion resistant plastic,



Puzzled about getting the Right Explosion-Proof Lighting Equipment?

Only Crouse-Hinds has everything you need

...in every class ...in every group!

For *complete* protection when making lighting installations in hazardous locations you need more than explosion-proof or dust-tight lighting fixtures. You also need UL-listed explosion-proof switches, junctions, fixture supports, unions and seals.

Crouse-Hinds now offers a broad selection of Condulet* explosion-proof lighting equipment for Class I, Groups A and B locations. In fact, you can specify complete Crouse-Hinds explosion-proof lighting installations, all UL-listed, *no matter what class or group of Article 500 of the National Electrical Code is involved.*

The same holds true for the entire Crouse-Hinds Condulet line of more than 15,000 conventional and explosion-proof items. With the broadest line in the field, Crouse-Hinds recommends *exactly* what you need . . . and *only* what you need.

A nearby Crouse-Hinds distributor will be glad to discuss your explosion-proofing problems and make recommendations without obligation.

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BARCO Swing Joints and Assemblies

5 Reasons for SUPERIORITY!

1. **BALL BEARING AND O-RING EQUIPPED**—Designed specifically for handling gasoline, oil, lube oil, LP gas, petro-chemicals, and other petroleum products.
2. **LARGE BEARING SURFACE**—Barco's bearing design provides adequate support for lengths of piping. Minimizes bearing pressures and wear.
3. **CONTROLLED TORQUE**—No annoying, uncontrolled swinging of lines. They swing easily but stay put.
4. **LONG LIFE**—New "Bar-Moly" dry lubricant process gives a permanent anti-galling, corrosive-resistant finish to moving parts. This, combined with routine lubrication, insures longest possible maintenance-free service.
5. **EASY MAINTENANCE**—Joints can be disassembled for inspection without disconnecting piping. O-rings are easily renewable in the field. No greasing is required to maintain sealing.

The Barco line is complete with single swing, double swing, and counter-balance styles and assemblies to meet every need. Sizes 1", 1½", 2", 2½", 3", 4", 6", and 10". All steel or malleable iron. Send for latest Catalog No. 400 containing engineering and ordering information. *Worldwide sales and service.*

BARCO MANUFACTURING CO.
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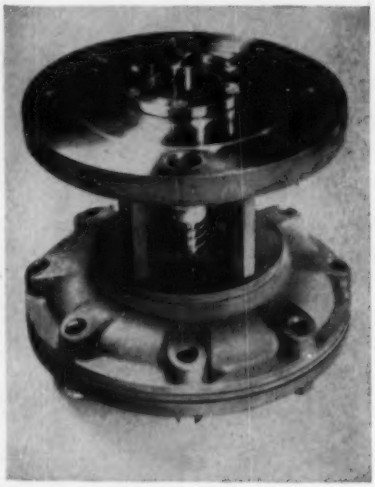
Barrington, Illinois
In Canada: The Holden Co., Ltd., Montreal

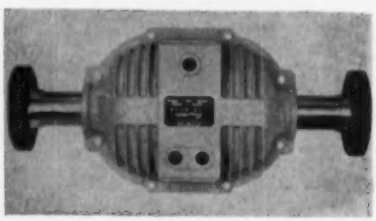
New Equipment . . .

can be made an integral part of the overall exhaust system. Haveg Industries, Inc.
Circle E5 on the card.



Pressure Transmitter—Operating on the force-balance principle, the Model "P" pressure transmitter, a lightweight, rugged, yet highly sensitive unit, is ideal for services involving viscous substances, or materials which solidify in the static lines of bourdon tubes. It also has wide application for liquid level indication on open tanks containing viscous materials or those with solids in suspension.

The model is unique in that it utilizes simple, flat diaphragms in lieu of bellows. This eliminates the problem of viscous materials hardening in bellows convolutions. Diaphragm material is of rubber, Teflon, or Stainless steel, depending on the temperature range and corrosiveness of the service. The supersensitive pilot is completely isolated from the pressure diaphragm so that controlled gas or liquid cannot back up into air lines in event of diaphragm failure. Conoflow Corporation.
Circle E6 on the card.



Smaller Magnetic Flow Meter—Previously limited to a minimum line size of 2 inches, this magnetic flow meter is now available for 1-inch flow lines. The smaller meter offers all the unique advantages of the larger instruments (2 inches and up); namely, over-all accuracy of ±1 percent of full scale throughout the entire scale, no restriction of flow, linear flow readings, performance unaffected by pressure, viscosity, density or changes in conductivity of the flowing liquid.

The unit consists of a nonmagnetic flow tube with an insulating liner containing flush-mounted metallic electrodes and sur-

Why Oilwomen Everywhere are Saying...

"Have Magic Suitcase ...Will Travel"

Every woman is interested in beauty—clothes—homemaking. But not every woman knows how big a part *oil* plays in a woman's world! That's why the Oil Industry Information Committee sponsors a Women's Program.

Today, hundreds of oilwomen—industry employees and oilmen's wives—help tell the story of oil in an interesting and dramatic way. The "Magic Suitcase" is one way. It contains products made from petroleum—cosmetics, detergents, oil-based "miracle" fabrics and many other items a woman uses in her daily life. This demonstration—as well as other lectures and displays—shows her how *oil* and *oil* products help make her look more beautiful and make her housework much easier.

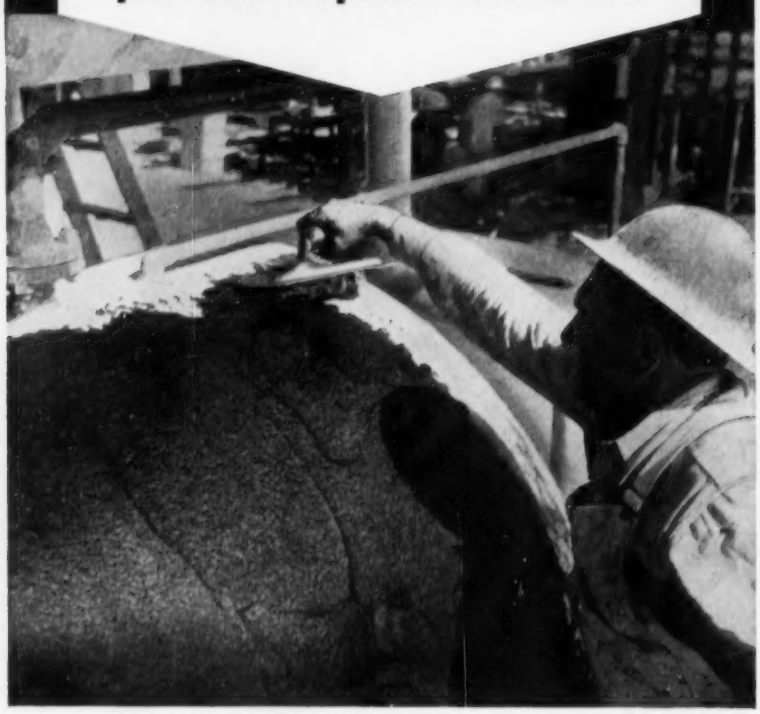
The Women's Program is only one of many ways through which your OIIC helps show the public that it is best served by a privately-owned, fully competitive oil industry. If *you* would like to aid in the Women's Program—or another of OIIC's many activities—contact the OIIC in your area today. You'll not only be helping your industry but you'll get a wonderful sense of personal satisfaction from it as well.

For the address of your local OIIC office, write to...

AMERICAN PETROLEUM INSTITUTE, 50 W. 50th St., New York 20, N.Y.

For more data on advertised products, use Readers' Service Cards, last page.

Laykold® WEATHERCOAT
protects exposed insulation



INSULATION on towers, tanks and exchangers must be kept DRY. If moisture gets through, the efficiency drops.

Modern refinery and plant design places many major insulated vessels "in the open." You can maintain the efficiency of your insulation with easy-to-apply Laykold Weathercoat.

Weathercoat is a fibrated asphalt-base material of easy troweling consistency that dries to a black, remarkably tough and tenacious coating. A majority of the leading refineries are regular users of Weathercoat.

A new product: Mastic Weathercoat, a bodied material, for use wherever economy demands the application of a *single*, thick layer.

Write today for our free illustrated brochure, entitled "Laykold Weathercoat for Insulation Protection."

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New Equipment . . .

rounded by an AC electromagnet. When a conductive liquid passes through the tube, an alternating voltage is set up between the electrodes which varies linearly in proportion to the rate of flow. Lead wires from the electrodes transmit this voltage output to a recorder, producing a chart record in appropriate units of flow. The Foxboro Company.

Circle E7 on the card.

Condenser Gun—A super-jet condenser cleaning tool that provides extremely fast and effective cleaning of condenser tubes is now available. It utilizes a handy gun-and-slug method to thoroughly remove slime and scale at a considerable time savings over ordinary mechanical methods. One man can quickly load an entire bank with cleaning slugs and shoot them through in rapid succession. The result is substantially reduced labor and shut-down time.

The gun is a lightweight rugged duty tool, weighing only 2¾ pounds, which an operator can use for lengthy periods of time without fatigue. It can be operated by either air or water pressure. Effective pressures range from 50 to 200 psi.

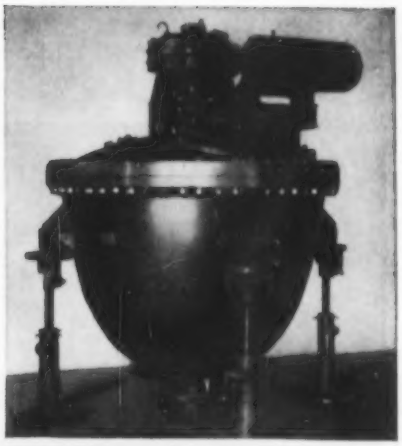
Three types of cleaning slugs in sizes to fit all standard tubes can be furnished. They are specially designed for positive cleaning under practically all conditions. Spool-type slugs, for normal slime removal, are designed with a cup at the forward end which expands to wipe the inside of the tube clean. Bullet-shaped slugs are for removing heavier or thick slime deposits. Scraper-type slugs cut away scale or mineral deposits as they are driven through the tube. The latter two types have "jet action" holes in the side wall to admit water or air for flushing away deposits as they are removed. Crane Packing Company.

Circle E8 on the card.

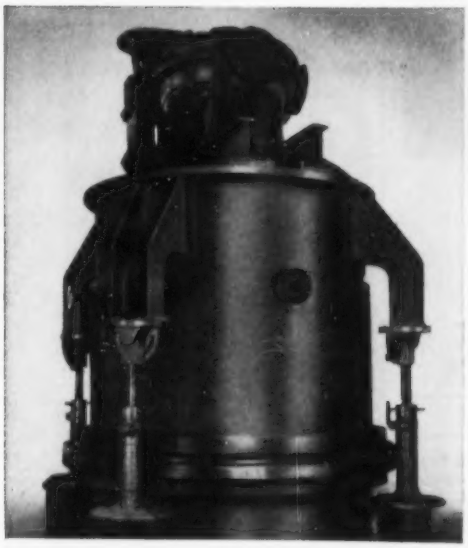
Corrosion Proof Mortar—A new type of corrosion-proof mortar is the latest development in silicate bonding material. Especially designed for the installation and maintenance of stack linings and acid tanks, Corlok is based on a precisely adjusted potassium silicate, is essentially free from sodium silicate or other sodium compounds, and contains no fluoride setting agent. It withstands strong oxidizing acids, nitric, chromic and concentrated sulfuric, and is resistant to sulfation and highly concentrated acids at temperatures up to 1900 F. for longer periods than any other acid-proof silicate cement. The product is non-corrosive to metals and will not react with lead or chrome-nickel alloys.

Two materials are used to prepare the new mortar—a potassium silicate solution

Buflovak...50 years experience matching kettles with requirements



500-gallon one-piece cast jacketed Pressure Saponifier with Double Motion Agitator.



1500-gallon Dowtherm heated, jacketed Kettle with Double Motion Agitator and Thermocouple.

3000-gallon steam jacketed, fabricated steel Grease Mixing Kettle.

To a great extent, processing profits depend upon the quality and efficiency of the processing equipment. Proper equipment design is in turn determined by such factors as end product, quantities to be handled, method of heating and cooling, agitators and drive to be employed, heat source, and high or low temperature control.

Blaw-Knox engineers have the years of practical experience and technical know-how necessary to combine all these factors into equipment that will best meet *your* processing needs. We can build kettles to your design; or, engineer, design and construct kettles to meet your requirements. Either way, Buflovak Kettles are your assurance of highest processing profits. Write or call us today about *your* processing problem.

a broad process equipment service

Kettles of every description constitute but one phase of Blaw-Knox Process Equipment design, engineering and fabrication service for the chemical, food, pharmaceutical, plastic and resin, petroleum, rubber and other industries:

EVAPORATION • DRYING • FLAKING
MIXING • IMPREGNATING • REACTION
VULCANIZING • SOLVENT RECOVERY
SOLVENT EXTRACTION • STERILIZING
CRYSTALLIZATION • DISTILLATION
POLYMERIZATION • GAS CLEANING
GAS ABSORPTION • VAPORIZATION
CONDENSATION • HEAT TRANSFER
LOW AND HIGH PRESSURE PROCESSING

Write for Bulletin 356-R for more information on Buflovak Processing Kettles for heating, cooling, mixing, drying, concentrating, crystallizing and reactions.

50th Anniversary BLAW-KNOX 1906-1956

BLAW-KNOX COMPANY

Buflovak Equipment Division
1601 Fillmore Avenue, Buffalo 11, New York

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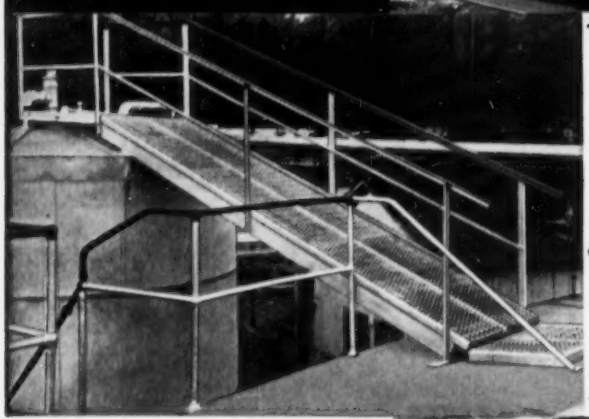
For more data on advertised products, use Readers' Service Cards, last page.

Use SAFETY GRIP-STRUT grating

Wherever a safe footing is required



Grip-Strut circular stairway on Shell Oil tank in Portland, Ore.

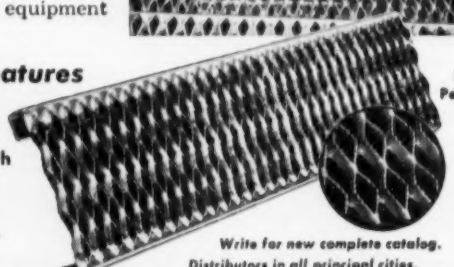
See how Shell Oil uses Grip-Strut for a safe ramp between tanks.

View looking down circular stairway on Shell Oil tank shown above.

SAFETY GRIP-STRUT is the new basic material, all in one piece (including channels), not welded, riveted or expanded in steel or aluminum, in standard sizes and gauges. Safety GRIP-STRUT presents an open space, in a diamond pattern, in excess of 55% of the area for ready access of light and air and gives a positive NON-SKID footing in all directions. Ideal for work platforms, stair and ladder steps, flooring, balconies, catwalks, machinery guards, fire escapes and for original equipment safety treads.

Important Safety Features

- ★ Fire proof
- ★ Slip proof
- ★ Maximum strength
- ★ Minimum weight
- ★ Easy to stand on
- ★ Cool in summer—warm in winter



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New Equipment . . .

which is entirely new, and a powder, packed in 100-lb. polyethylene-lined bags, dated to ensure best results within a specified time limit.

The manufacturer recommends this special type mortar for laying acid-proof brick or tile in combustion gas condensation and sulphuric acid production services; for structures in which maximum bond strength is essential, and where improved impermeability is desired. Pennsylvania SaH Manufacturing Company.

Circle E9 on the card.

New AC-DC Arc Welder—This new AC-DC and inert gas arc welder is rated 200 amperes, 40 volts and has a current range of 10 to 300 amperes, AC or DC.

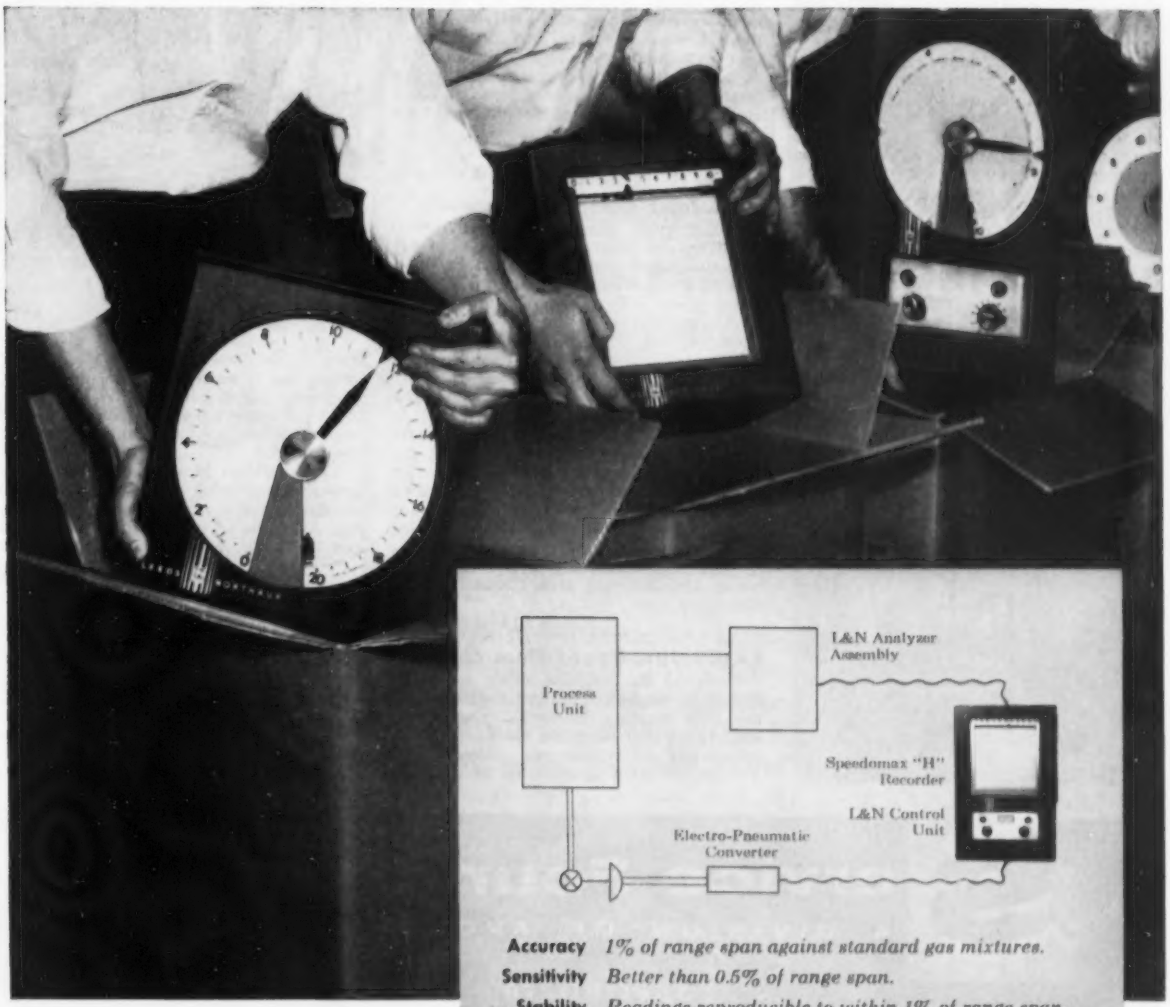
Features include new case with easily removable side panels, recessed control panel and selector switch which permits operator to choose AC, DC straight, or DC reverse welding current. It also has a magnetic contactor and removable rheostat for remote control at no extra cost. Hobart Brothers Company.

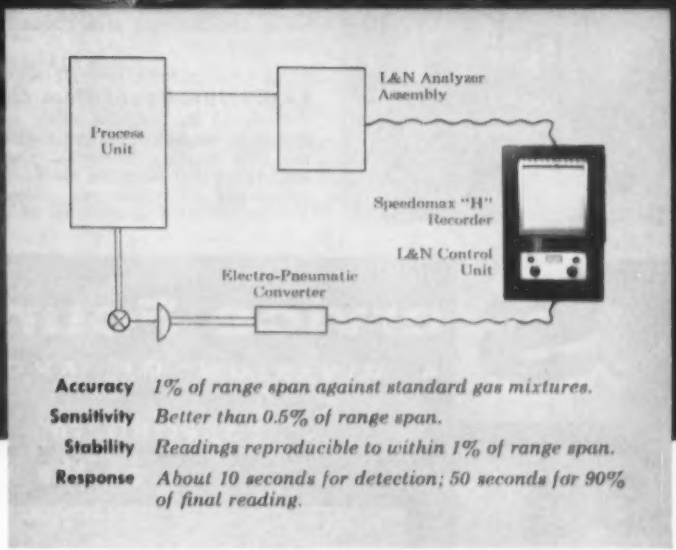
Circle E10 on the card.

Chemical Calculator—A convenient six-scale slide calculator designed to provide accurate and rapid chemical treatment costs and quantity conversions is available. Aimed primarily for use by the petroleum industry, the calculator scales have been expanded to be useful to other industries where chemicals are used in parts-per-million treatment rates. Armour and Company, Chemical Division.

Circle E11 on the card.

New Sizes for Drain Valve—Originally available only in ¾- and 1-inch size, the No. 23 drain or sampling valve is now being made in standard sizes of 1¼ inch, 1½ inch, and 2 inch. This valve is com-





Accuracy	*1% of range span against standard gas mixtures.*
Sensitivity	*Better than 0.5% of range span.*
Stability	*Readings reproducible to within 1% of range span.*
Response	*About 10 seconds for detection; 50 seconds for 90% of final reading.*

Filling the demand for economical Process-Gas Analysis

. . . is our new family of compact Speedomax® Type H thermal conductivity recorders and controllers. They're teamed with established L&N thermal conductivity cell equipment for an economical new approach to process gas measurement and control.

These Speedomax H instruments couple the most-wanted performance features of their well-known Speedomax G parent with small (11" wide) size, and economies in price. Modern manufacturing methods cut production costs and delivery time without sacrificing the resolution and operating precision for which process men specify Speedomax.

Control through the Speedomax H instruments can be either all-electronic or electro-pneumatic. The 3-action Series 60 Control Unit, used for either form of control, plugs compactly into the Speedomax case. Its replacement parts are also plug-in for service ease. Ranges available include: 0 to 20% CO_2, 0 to 15% SO_2, 0 to 20% SO_2, 95 to 100% H_2 in O_2, 95 to 100% O_2 in H_2, 0 to 100 uncalibrated.

Want details? Write for Folder ND46-91(6) to Leeds & Northrup Company, 4923 Stenton Avenue, Philadelphia 44, Pa.

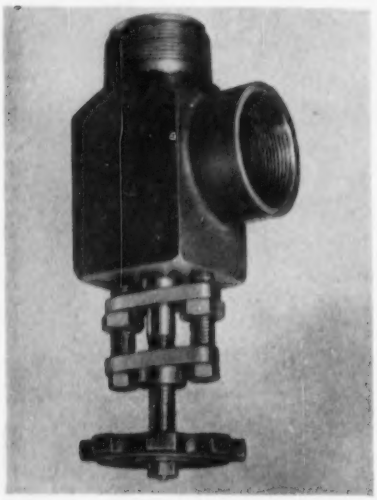
LEEDS Instruments **NORTHRUP** Automatic Controls • Furnaces

For more data on advertised products, use Readers' Service Cards, last page.

New Equipment . . .

pletely self draining and can be used for installations where it is desirable to have the valve seat inside the wall of a vessel to prevent liquid from remaining in the nipple and valve.

The ¾- and 1-inch sizes are recommended for pressures of 4000 pounds at 100 F. and 1000 pounds at 750 F. The 1¼, 1½, and 2 inch sizes are recommended for 600 pounds at 100 F. and 250 pounds at 750 F. Standard materials are carbon steel body, stainless steel stem and



Stellited seat. Also available in stainless steels, bronze and other special alloys to meet corrosive or other extreme conditions. Optional features include construction with additional outlet for such uses as a steaming out connection and with a reamer on the end of the stem to break away encrusted matter which may have collected on the inside vessel wall. Jerguson Gage & Valve Company.

Circle E12 on the card.

Pipe Joint Compound—A new Teflon-based pipe joint compound that will positively seal practically all known highly corrosive liquids and solvents has been developed for services up to 212 F. This material is not only impervious to all types of hard-to-handle fluids, but possesses an extremely low coefficient of friction. The latter substantially reduces wrench torque, permitting connections to be drawn up to a greater degree of tightness without undue stress or strain.

The non-adhesive quality of Teflon and the non-hardening characteristics of the compound allow the connections to be quickly and easily disassembled, even after years of severe service. Chemlon pipe joint compound is particularly adaptable for use on aluminum, stainless, monel or plastic pipe and is currently available in two-ounce screw-type jars. Crane Packing Company, Ltd.

Circle E13 on the card.

Explosion-Proof Floor Machine—Designed for complete safety when operated in explosion or fire hazard areas, this floor machine features a new switch mechanism that turns the machine off automatically when operator releases grip. The switch itself is mounted in a sealed

unit on the motor and is controlled remotely by a single lever on the handle. The need for a bulky sealed switch unit on the handle has been eliminated, thus improving balance and handling ease for the operator.

The machine is also equipped with a power transmission which eliminates all metal-to-metal contact in the drive housing. Available in two brush sizes—14-inch and 16-inch. Advance Floor Machine Com-

Circle E14 on the card.

New Rupture Discs—A new type rupture disc has been developed that extends the advantage of safety head protection to many installations now operating under pressure, temperature and corrosive conditions too severe for conventional type discs. The new D and DV Rupture Disc extends the range for high temperature applications, provides maximum service un-

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Avondale's foundry lives up to its name —"SERVICE" gives service, and of a specialized nature. Service Foundry thoroughly understands the needs of the oil man—and is fully equipped to dispatch all orders in an expert manner. The next time you need castings in iron, steel or non-ferrous materials — gear cutting or machine work . . . call for "SERVICE"— Service Foundry, New Orleans.

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UNICOR is added only at the points of product entry, is distributed uniformly over the entire internal surface and effects 100% protection.

UNICOR is inexpensive to use, too. Actually, only one or two molecules of UNICOR are required for every 1,000,000 molecules of gasoline. This makes UNICOR's cost only about $0.0005/bbl. of pipe line product. There are additional savings, too, in reduced scraper-cleaning and filter replacement costs.

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PRODUCTS DEPARTMENT

UNIVERSAL OIL PRODUCTS COMPANY

UOP

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DES PLAINES, ILLINOIS, U. S. A.

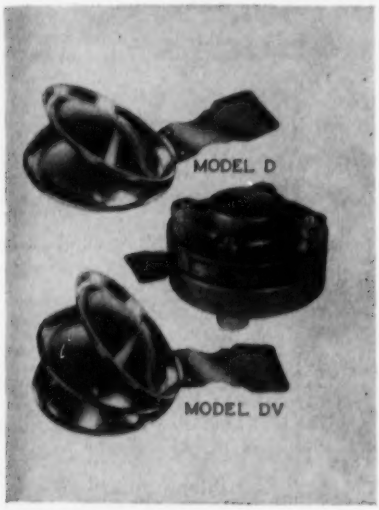
For more data on advertised products, use Readers' Service Cards, last page.

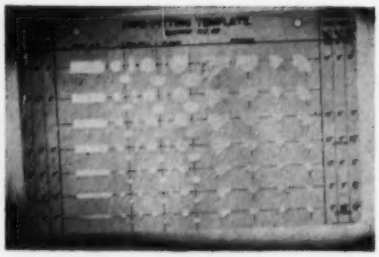
New Equipment . . .

der pulsating or reversing pressure conditions, and permits closer operation to rupture pressure. The new disc also makes lower minimum rupture pressures possible and gives extended service under pressure surges that approximate the rupture pressure.

Complete information on the D and DV Rupture Disc is included in Catalog 77-31. Black, Sivalls & Bryson, Inc.

Circle E15 on the card.





Pipe Detail Template—The most commonly used pipe fittings symbols have been condensed onto a single template whose two imprinted tables permit the user to transpose quickly in six different scales.

The 5¼ x 8½-inch template contains 91 apertures including foreshortened views. Printed tables relate the symbols to ⅛, ¼, ½, 3/16, ⅜, and ¾ inch scales. A. Lawrence Karp.

Circle E16 on the card.

Hydrazine Feedwater Treatment—A new, completely non-flammable form of hydrazine for deoxygenation of boiler feedwater has been placed on the market. Called Scav-Ox, the product is a 35 percent solution of hydrazine in water. It has no flash point and no fire point, yet retains all of the advantages of hydrazine as an oxygen scavenger and corrosion inhibitor.

Hydrazine has a much higher oxygen removal efficiency than sodium sulphite which means that less of the treating material is required. One pound of hydrazine will remove as much oxygen as eight pounds of sodium sulphite on a theoretical basis. In actual practice, however, it is customary to maintain a high residual of sodium sulphite in the boiler water, so that in many cases hydrazine is able to replace as much as 50 times its weight of sulphite.

Another major advantage of hydrazine is that it does not put solids into the water. Sodium sulphite adds dissolved solids, either as the original sulphite or as sodium sulphate after reaction with oxygen. These build up a coating on the boiler tubes and drum surfaces which reduces boiler efficiency and is hard to remove. Hydrazine is a clear, water-white liquid, and the only reaction products with oxygen are nitrogen and water, neither of which is detrimental to the boiler or its operation. Olin Mathieson Chemical Corporation.

Circle E17 on the card.

Single Plane Swivel Joints—A catalog sheet covering a new line of plane swivel joints has just been published. These joints are of the "single plane" swivel type and are offered in ¼, ⅜, ½, and ¾ inch sizes.

Designed primarily for hydraulic and pneumatic service, these leakproof, flexible connectors greatly reduce maintenance costs of piping, tubing or hose lines, since damaging, twisting stresses are completely absorbed by the free 360 degree swiveling of the joints. The new joints also permit better engineering of equipment and often eliminate long radius bends and reduce length of hose required.

The joints are of compact, lightweight, unitized construction with steel sleeve and aluminum casing. A special plastic back-up ring with O-ring static seal provides leakproof seal. Two types with very low turning torque are available with straight or angle connections—a ball bearing type for

CENTRIFUGAL SYNTHESIS GAS CIRCULATORS

GHH Maulwurf pumps are high pressure centrifugal gas circulators especially designed for application in the chemical industry to increase the pressure of the nitrogen-hydrogen mixture in ammonia synthesis.

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BLOWERS
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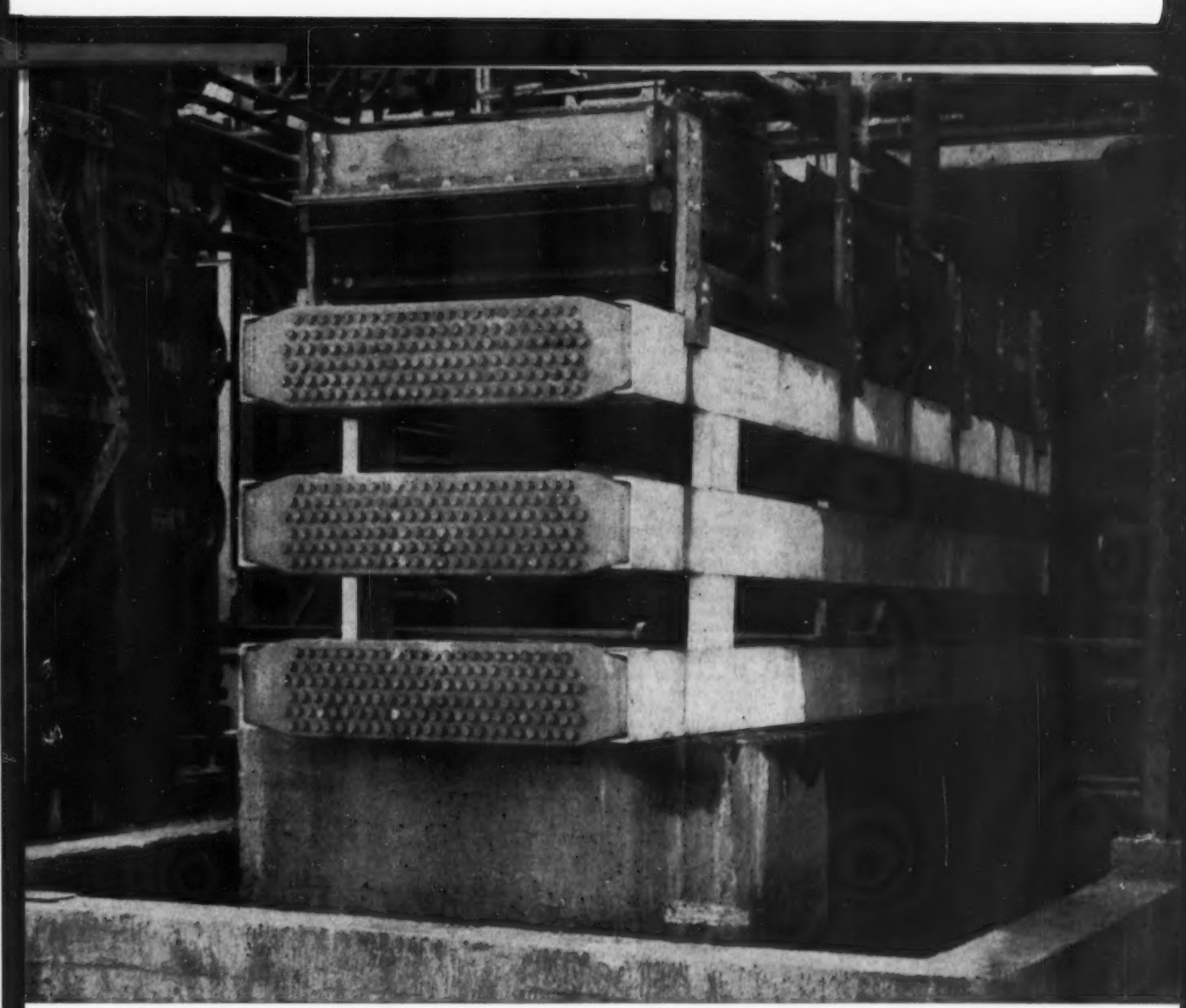

less slime . . . more heat transfer with Stainless Steel tubes

Carbon steel tubes were previously used in this copper solution cooler, but they built up slime and scale rapidly. This reduced the heat transfer coefficient, and made it necessary to clean tubes frequently.

So the tubes were replaced with type 304 Stainless Steel. Cleaning has been practically eliminated. The tubes are expected to last indefinitely, and the increased heat transfer has reduced the output feed stock temperature by a good ten degrees.

Here is a Stainless Steel feature that is sometimes overlooked: the smooth, dense surface repels filth and contamination. In heat exchangers, this results in lower fuel costs and maintenance costs. As a bonus, you have the great corrosion resistance and strength that make Stainless Steel so popular in modern refineries. But be sure of service-tested quality; specify USS Stainless Steel.

UNITED STATES STEEL CORPORATION, PITTSBURGH · AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO · NATIONAL TUBE DIVISION, PITTSBURGH
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
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USS STAINLESS STEEL

SHEETS · STRIP · PLATES · PIPE · TUBES · WIRE
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USS

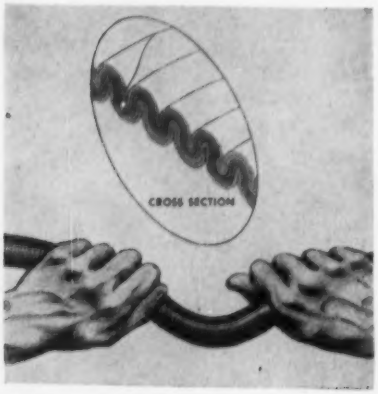
8-1299

UNITED STATES STEEL

New Equipment . . .

steady or severe service, and an economical thrust bearing type for general use. Barco Manufacturing Co.

Circle E18 on the card.



Plica Tubing—A unique line of bendable tubing having unusual installation advantages, known in Europe and elsewhere as PLICA, is now being made and sold in the USA under exclusive rights acquired from Switzerland.

In Switzerland and other countries, this tubing has been used extensively during the past ten years as electrical conduit. It has proven ideal for burying in concrete, ceilings and floors. As it can be cut with a hacksaw or knife, bent by hand to stay bent, and fits all standard connectors, installation times are substantially reduced.

Plica tubing has a three-ply wall and can be made in almost any desired combination of ferrous and non-ferrous metals, fiber, paper and other materials. The tubing is made by fully automatic machines in continuous lengths. It has high wall strength, watertightness and sharp bending radii.

The tubing, made of copper, brass, aluminum, steel, asbestos, fiber, paper, and combinations of these materials, is used for lubricating, coolant and other non-corrosive liquid lines, hot and cold air ducts, mechanical protection and insulation of pipes, flexible shaft casing, and for a wide variety of other uses.

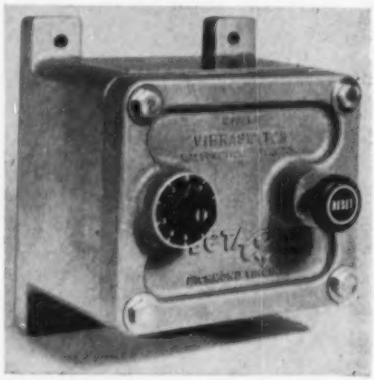
The size range is ⅜-inch through 2-inch i.d. Descriptive Bulletin 61 gives further details and prices. The Flexaust Company.

Circle E19 on the card.

Gearless Power Hack Saw—A new reciprocating saw attachment for electric, air drills and flexible shafts, has recently been improved in mechanical design. A completely new blade-holder replaces the previous holder, and is said to securely grip the saw-blade, holding it firmly in position against the chuckplate with 2 cone-tipped set screws.

Removal of the blade is expedited by a simple turn of standard Allen socket set screws. In addition to the new blade holder, the entire wobble-shaft mechanism has been redesigned with improved balance, insuring a full ⅞-inch stroke with vibration reduced to a minimum. The wobble-shaft is the mechanism that converts the rotary action of the drill to a reciprocating motion. The entire weight of the new Saw-Mor is only 3½ pounds, permitting easy portability. Use it at the workbench, or carry it up ladders. Reaches into hard-to-get-at places. The newly redesigned saw is said to speed up sawing of all metals, stainless or monel, as well as wood, plastics, cable, composition, etc. Especially recommended for metal-working industries, body and fender work, electrical and building contractors, maintenance men, wrecking crews, etc. One of the many uses of the saw stressed by the manufacturer, is the safety factor it provides for cutting operations in the petroleum industry, powder plants and other areas where flame-cutting tools create a definite fire-hazard. Saw-Mor Tool & Blade Company.

Circle E20 on the card.



Vibration Switch—New vibration monitor anticipates and prevents trouble in rotating and reciprocating machines by

Now!
PRECISION EXPANDING MANDRELS
by CHAMPION

The expanding sleeve, mounted on tapered arbor, expands automatically to fit the hole. Inserted by hand — no arbor press needed. Always an exact, positive, concentric fit. Locked by a single mallet blow. Unlocked in the same way. CHAMPION Expanding Mandrels are used in machine shops around the world. Save time, cut production costs, whether the job calls for machining one piece or a thousand.

Precision Model has expansion range of .010". Available in regular sizes to fit holes from ½" to 9½" diam. Holds work to tolerances of .0002" run-out. Guaranteed for precision grinding, turning and milling operations.

Standard Model maintains close tolerances, handles material of any length bore, hard or soft metals — from thin tubes and bushings to heavy castings and forgings. A set of fourteen will fit every hole from ½" to 9½" diameter.

CHAMPION Expanding Mandrels can be made in special shapes and sizes to fit any specifications. Quotations on request. Write for descriptive folder today.

Certain areas are available for qualified distributors.

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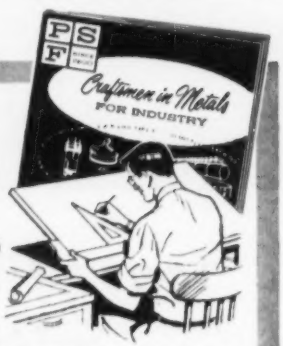

CUSTOM FABRICATING DATA—*Request New Brochure K-56*

This information on plant facilities and services will be of value to purchasing, procurement and engineering personnel when planning the custom fabrication of . . .

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for the Petroleum Processing Industry on the West Coast

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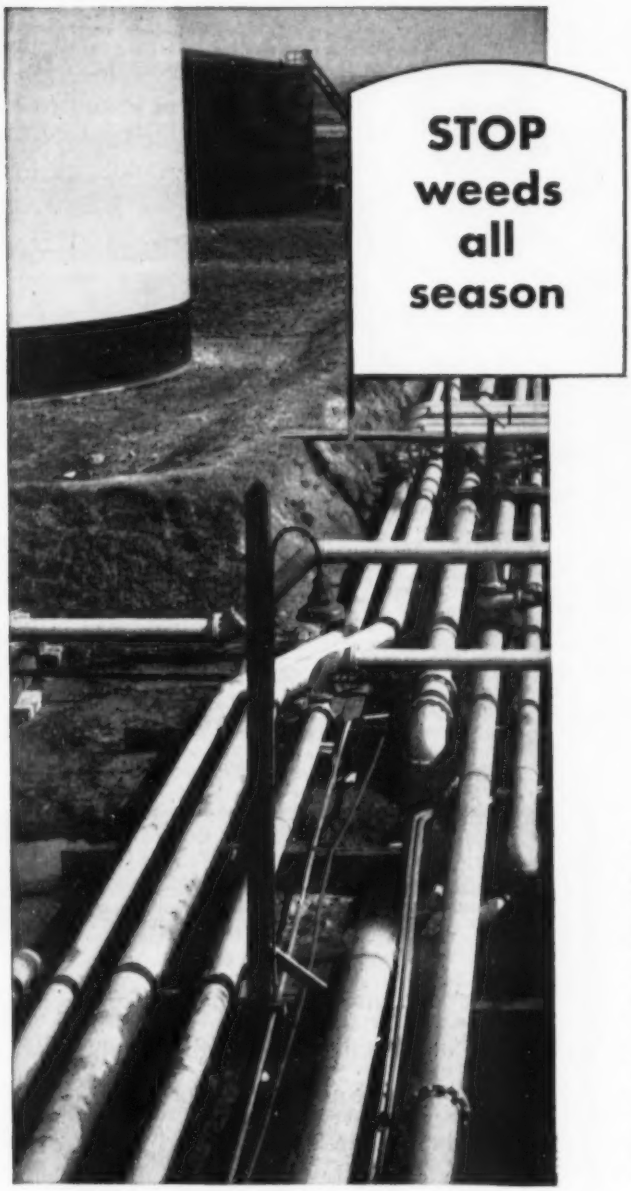

Still weed-free one year after treatment with "Telvar." The area around the tanks and pipeline was sprayed with a single treatment of "Telvar" a year before this photo was taken. Weed-control costs are cut with "Telvar" because it gives thorough, long-term weed control.

FREE ILLUSTRATED BOOKLETS describe how to control weeds and brush with Du Pont chemicals. Write to Du Pont, Grasselli Chemicals Dept., Rm. D-4032, Wilmington, Del. In Canada, Du Pont Company of Canada Limited, 80 Richmond Street West, Toronto, Canada.

Spray just once with Du Pont TELVAR®

WEED KILLERS

When you use "Telvar" weed killers, vegetation is killed through the roots and regrowth is prevented because the chemical remains in the soil . . . provides residual action all season long. And low dosages (1 to 1½ lbs. per 1,000 sq. ft.) make it cost little for the results you obtain. Such low rates also mean less handling, less use of storage facilities.

"Telvar" weed killers come as wettable powders, are non-corrosive, non-flammable, non-volatile, low in toxicity to humans and livestock.

Include "Telvar" weed killers in your weed-control program this year. Prove to yourself how these products of Du Pont research can help cut your maintenance cost to new low levels.

• • •

Where brush is a problem, Du Pont Ammate® X weed and brush killer is the product you need. It kills more kinds of brush with unusual safety. With ordinary precautions, "Ammate" X may be used close to such crops as cotton, tomatoes, soybeans and peanuts.

On all chemicals, follow label instructions and warnings carefully.

DU PONT
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WEED and BRUSH KILLERS

BETTER THINGS FOR BETTER LIVING...*THROUGH CHEMISTRY*

For more data on advertised products, use Readers' Service Cards, last page.

New Equipment . . .

responding to slight increases in roughness or vibration and causing a shutdown before a costly failure occurs. Examples of detectable malfunctions are failing bearings, bent shafts, unbalance, broken blades, etc. Applications include pumps, motors, compressors, blowers, gas engines, diesels, centrifuges, turbines, generating equipment, test stands, etc. It may be used singly on small equipment; in pairs on driving and driven equipment, or in series or parallel combinations to monitor each bearing. Acceleration range is 0-2G's to cover all types of rotating equipment at speeds up to 18,000 RPM.

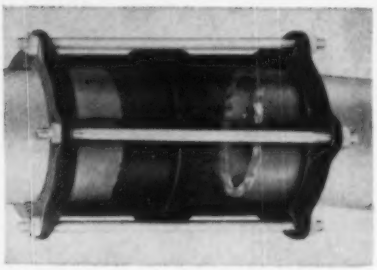
The Model 5 VIBRASWITCH includes a shock-free holding and reset mechanism for automatic or remote operation to prevent actuation from starting or from normal or accidental transient shocks. (These features have previously been available only in electronic monitors.) The unit employs no vacuum tubes or electronic components, is maintenance-free and fail-safe. It is supplied in an explosion proof housing for Class I, Group D; Class II, Groups F and G locations, or gasketed for non-hazardous outdoor locations. The housing is of cast aluminum threaded for ¾-inch conduit. Terminals are provided for heater resistor to prevent condensation in semi-tropical or tropical climates. The Beta Corporation. **Circle E21 on the card.**

Safety Shut-Off Valve—A new and unique safety shut-off, manual reset, solenoid valve is described in Bulletin 8022. These valves are used in gas supply lines leading to boilers, furnaces, ovens and

other heating equipment to shut off the fuel automatically and instantly upon failure of power. They can also be used to handle various grades of fuel oil and non-corrosive liquids and gases. Sizes available are from ¾ inch to 6 inch; pressures from 25 to 100 psi. Automatic Switch Company. **Circle E22 on the card.**

Flexible Repair Coupling—An improved coupling for repairing misalignment breaks in water, gas or oil pipelines has been developed. It is applicable to cast iron, asbestos-cement or steel pipe and is installed with the pipe in place. This cut-in coupling acts as a double coupling replacing twice the length of pipe cut out. The pipe is repaired quickly, as well as given additional flexibility, simply by cutting out any break, broken flange, bell or pipe coupling and using the cut-in coupling.

The pipe can be out of alignment over



6 degrees and be repair-connected in place. The cast units are made with ductile iron flanges and cast iron sleeves to resist corrosion so that the flexible coupling will last as long as the pipeline on which it is installed.

Sizes from 2 through 12-inches are now in production. Larger sizes, in steel, are also available. A new bulletin describing the Series 4K cast cut-in coupling is available. Smith Blair. **Circle E23 on the card.**

The CARD referred to in these columns is the convenient Readers' Service Cards that appear as the last page in each issue of PETROLEUM REFINER. You are invited to make use of these cards. No postage is required if card is mailed in U.S.A.

Completely New
Precision Scaler

Model DS8

The DS8 Precision Scaler is a COMPLETELY NEW fast scaling circuit. It is an ideal scaler for counting pulses from a pulse-height analyzer. Many of its outstanding features are *new developments* not available in any other scaler. Some of these features are (1) PRECISION pulse-height selector; (2) improved low-current scaling stages; (3) regulated plate supply with hermetically sealed transformer; (4) high-speed register driving circuit; (5) provision for cascading similar units for extending scaling factor.

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Your waste treatment problems
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A Specialized Engineering Service to STOP

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—from intake or discharge of air, steam or gas piped to atmosphere.

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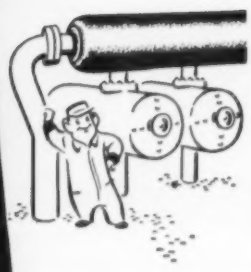
and

PULSATION—

—from surges created by compressors, pumps, blowers and pressure reduction systems.



The Burgess-Manning Snubbing Principle has, for many years, been engineered to varied problems of noise and pulsation in every branch of the petroleum, chemical, power and general industries. Noise and pulsation has been completely eliminated—production has been greatly increased, maintenance reduced with neighbor and labor relations improved.

Here is an engineering service, backed by years of experience and a proved principle of snubbing that will prevent and eliminate noise and pulsation problems.

We invite you to present your problems for recommendations.

Write **for your copies of case histories of representative installations and see the results for yourself.**

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new "AL-metal"

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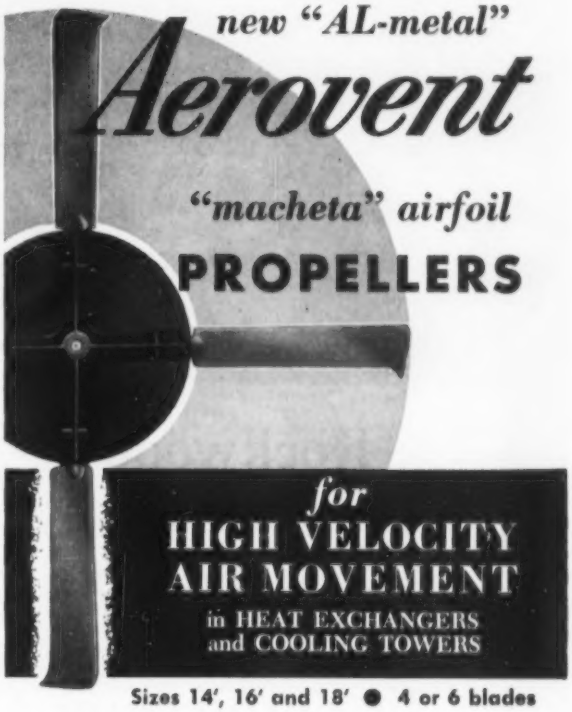
PROPELLERS



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HIGH VELOCITY AIR MOVEMENT

in HEAT EXCHANGERS and COOLING TOWERS

Sizes 14', 16' and 18' ● 4 or 6 blades

New Aerovent "AL-metal" Propellers for Cooling Towers, Heat Exchangers and special commercial and industrial applications, feature a new modification of the famous "Macheta" Airfoil Propeller – regarded for years as *industry's most efficient air-moving surface!*

Accurately-balanced, cast aluminum blades, designed to move *more* air with *lower* power consumption, are interchangeable with other blades in each assembly to speed and simplify installation and routine maintenance.

High-strength, cast steel alloy hubs, employing bolted construction, clamp keyed blade shanks securely to prevent loosening or turning; provide maximum resistance to vibration and operating stresses.

designed for DEPENDABLE *operation*

Endurance tests at 3 *times* normal loading prove the ability of new Aerovent "AL-metal" Propellers to withstand punishment far in excess of operating requirements.

Other models for any type installation

Write today for free folder, engineering assistance and/or detailed performance data

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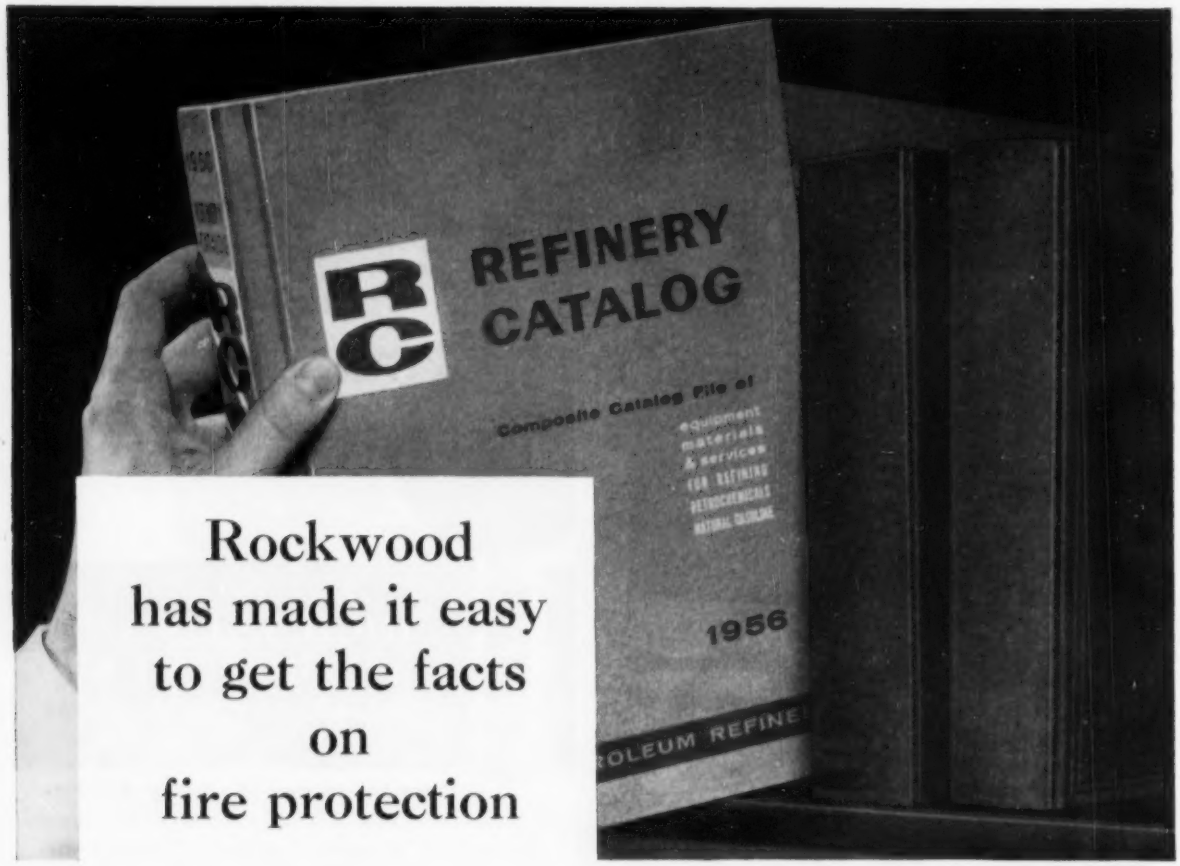

Rockwood has made it easy to get the facts on fire protection

It's a simple 1, 2, 3 step to get all the facts on fire protection in the Refinery Catalog.

Here's all you do...

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ROCKWOOD SPRINKLER COMPANY

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Engineers Water . . . to Cut Fire Losses

What's New in Manufacturers' Literature

For more data on New Equipment or copies of Catalogs and Literature reviewed in this issue, use the Reader Service postcards just inside the back cover and facing the Advertisers Index. Simply circle code numbers of items desired—sign and mail card.

New Algaecide—A new simple, low-cost way to stop algae problems in cooling systems through use of No. 120 Series Algaecide is described in Bulletin 28X8434.

The new algaecide is a complex organic rosin base liquid, weighing approximately one pound per pint. It is simple to apply and safe to use. A table illustrates its effectiveness on six different species of algae.

The new algaecide is currently being used in numerous industries to successfully control algae and other microscopic organisms which complicate the over-all water treatment program in cooling systems. Allis-Chalmers Manufacturing Company. **Circle E24 on the card.**

Acetophenone is described in a new eight-page technical bulletin. Information is given on its properties, specifications, shipping containers, constant-boiling mixtures, and solubilities. Typical reactions are given. Included in the section on applications are descriptions of its use in the manufacture of certain drugs and resins.

This simple aromatic ketone is an excellent solvent for many gums, resins, dyestuffs, and high-melting aromatic chemicals. It can be used as a process solvent under oxidizing as well as reducing conditions.

Acetophenone reacts to form compounds useful as resins, pharmaceuticals, corrosion inhibitors, dyestuffs, and in making synthetic rubber. It is an intermediate for phenyl methyl carbinol which is used by the perfume industry and in making styrene. Carbide and Carbon Chemicals Company. **Circle E25 on the card.**

Air Conditioning Pumps—A revised bulletin on centrifugal pumps for air conditioning systems has been issued. Available with heads to 120 feet and capacities to 240 gpm the monobloc centrifugal pumps are designed to offer a wide range of sizes to fit every pumping system. The pumps feature oversize ball bearings for long trouble-free lift; standard industrial type motor; one-piece pyramid base, end shield and bracket. They can be mounted horizontally, vertically, or on the wall.

Bulletin W-306-B3D-P graphically illustrates ratings, dimensions and variety of sizes carried in local stocks maintained at the Atlanta, Charlotte, Cleveland, Dallas, Harrison, Houston, Los Angeles and New Orleans district warehouses. Worthington Corporation. **Circle E26 on the card.**

Moly-Sulfide Grease—An eight-page Bulletin Lu-8a, explaining how the lubricant additive Moly-Sulfide functions in chassis grease and detailing its properties and current technological status, has just been issued.

The booklet reveals that extensive fleet tests on package-delivery trucks, long-distance trucks and trailers, buses, police cars and utility maintenance trucks are now in progress to check the performance of chassis greases containing moly-sulfide under actual road conditions. These controlled tests have been undertaken because laboratory and field experiences indicate that the addition of 3 percent moly-sulfide of a fine particle size to chassis grease reduces wear on critical points and extends the lubrication period.

Moly-sulfide, it is explained in the bulletin, functions by depositing out of the

For Fire Risks Specify Planet Flameproof Diesel Tractors

F. C. Hibberd & Co. Ltd.

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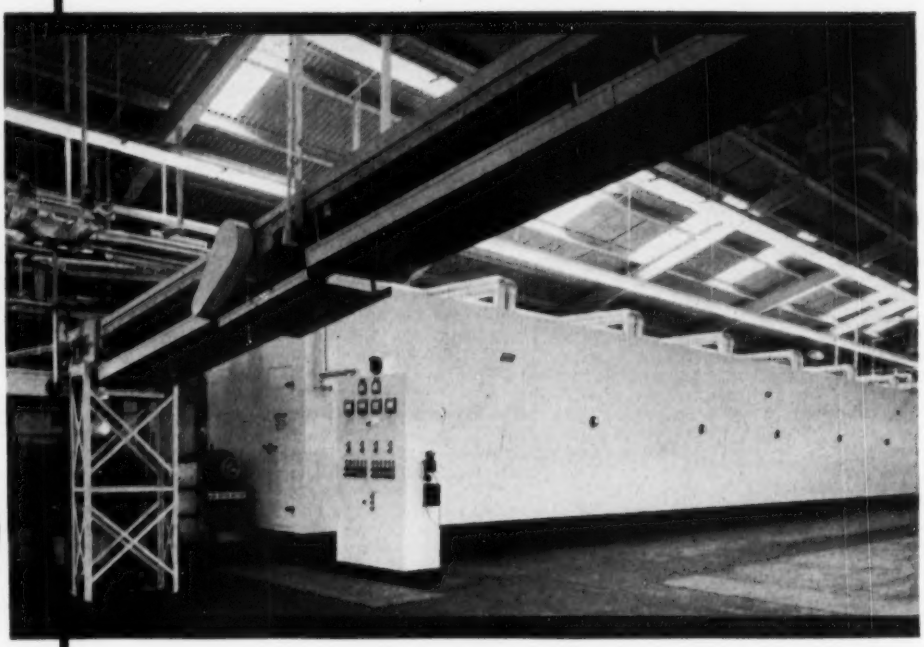

New profits from Wax

MORE AND MORE refiners are slabbing wax faster, more economically with GREER Wax Moulders because Greer Moulding plants save labor and space . . . boost production . . . improve quality control.

ONE-MAN OPERATION . . . deposits, cools and demoulds cakes completely automatically. Virtually eliminates 85% of wax slabbing labor costs.

SAVES VALUABLE FLOOR SPACE . . . Packs your entire slabbing operation into floor space only 10 to 25% of that required by batch processes of equal capacity.

EXACT, DEPENDABLE WEIGHT CONTROL . . . Now you can mould cakes within ½ of 1% of desired weight — continuously, automatically. Automatic moulding means improved appearance and cleanliness of cakes, too.

NEW CHOICE OF SIZES . . . Ten-pound Slab Machine now available in two models from 2500-7500 pounds/hour, and 10,000-15,000 pounds hour.

WRITE for informative 9-page Bulletin 51-2

J. W. GREER COMPANY

WILMINGTON, MASSACHUSETTS

Sales Engineering Offices: Chicago, Ill., San Francisco, Calif.

GREER

What's New in Manufacturers' Literature

grease in a thin film that adheres tenaciously to the steel in the part being lubricated. When the grease is washed or wiped out of the bearing under normal or abnormal driving conditions, this film of moly-sulfide is present as "the second line of defense" to keep the bearing surfaces lubricated until the grease film is restored. This prevents galling, welding and fretting of parts, reducing wear and resulting in a smooth, quiet ride between servicings. Climax Molybdenum Company.

Circle E27 on the card.

Turbine Generators—A new 35-page bulletin on turbine generators covering the 1500- to 15,000-KW range has been released. Contents include complete information on types and applications, turbine and generator construction, testing and lubrication, sole plates, design features, and lagging.

A two-page fold-out illustrates a cutaway view of a typical multi-stage condensing turbine, and another shows an alternating current generator. Also included are various illustrations of industrial and municipal turbine generator installations. Worthington Corporation.

Circle E28 on the card.

Separators-Filters—A new catalog describing pipeline strainers, liquid separator-filters, and water separator-strainers is now available.

The liquid separator-filter is especially designed for separating water and solids from JP-4 and kerosine type fuels. A new vertical separator-filter featuring easy maintenance and quick installation is also described. The all-metal enclosed cartridges have a screw base and may be replaced as easily as light bulbs. Excel-so, Warner Lewis Company, Division of Fram Cor-

Circle E29 on the card.

NEMA Ratings—A new condensed motor catalog contains 300 pages of essential data condensed into a four-page ready reference with the only available complete cross reference between old and new NEMA ratings both horse power and dimensions. Covers current pricing for 1/20 through 1000 h.p. motor sizes on both fractional and integral h.p. motors. Includes adapter basis and prices from old to new NEMA frame mountings. Complete with popular standard motor modifications. Marathon Electric Manufacturing Corporation.

Circle E30 on the card.

Deaeration—Publication 4650 explains in capsule form the fundamentals of deaeration and why it is so necessary in water conditioning. The principles of operation as well as the advantages and application of the various methods of deaeration are discussed. Cochrane Corporation.

Circle E31 on the card.

Nitric Acid—This new four-page, two-color bulletin describes how efficient, low-cost production of nitric acid is possible. Typical operating requirements for the manufacture of nitric acid are included, along with a process description and simplified flow diagram. The Fluor Corporation, Ltd. **Circle E32 on the card.**

Tube Expander Catalog—Recently published Catalog No. 88 is crammed full of detailed information about tube expanders and associated tools used for tube rolling. The well-illustrated catalog, containing 119 pages, should be of interest to engineers and superintendents responsible for the maintenance or manufacture of such equipment as boilers, condensers, evaporators or miscellaneous heat exchangers. Special sections are devoted to expanders, general accessories, measuring instruments, rollers, extensions and drives. Not merely a list of the company's products, the catalog gives a detailed description and uses of each piece of equipment. It includes many new tools and methods in addition to standard equipment that has been available.

In addition, the catalog includes detailed, up-to-date information on tube expansion methods, tool maintenance, expansion calculations and charts giving pipe and tube sizes. Thomas C. Wilson, Inc. **Circle E33 on the card.**

Metering Pumps—A new twelve page, two-color booklet (#600) featuring metering and proportioning pumps as used in water conditioning has just been released.

This booklet illustrates typical installations for the injection of inhibitors in water conditioning systems, using proportioning pumps. Included are complete pump specifications, a table listing the chemicals most commonly used in water conditioning, what they are used for, and the pump construction best suited to inject them. Hills-McCanna Company.

Circle E34 on the card.

Asbestos-Cement Sheet—This illustrated, six-page folder explains how asbestos-cement sheet material can serve industry and shows typical applications. These include the use of asbestos-cement sheet for cooling tower housings; for cold storage room facings; for a weather protection on insulated outdoor tanks; and, for the construction of fume hoods and ducts. The folder gives complete information on physical properties, sizes, thicknesses and dimensional tolerances. Also, the folder has a section on cutting, working and applying. Johns-Manville.

Circle E35 on the card.

Odor Control—Objectionable odors released to the refinery atmosphere during processing can be removed without large capital expenditures by using "Alamask" specially designed aromatic chemicals. A new odor control bulletin describes how different types of chemicals can remove malodors from such processes as catalytic cracking units, separators, treating plants, sludge kettles, asphaltic stills, and many others. Feed rates and methods of application are also listed.

Other uses include abatement of diesel fumes by direct addition to the fuel and reodorizing petroleum products such as gasoline, sulfurized cutting oils, lube oils and oil sprays for insecticides. Rhodia, Inc.

Circle E36 on the card.

Chlorine and Caustic Charts—Two new illustrated wall charts presenting up-to-date instructions for the safe handling of chlorine and caustic soda have been prepared for users and handlers of these chemicals. The charts are printed in large type on weatherproof, plastic-impregnated paper and are suitable for hanging in either outdoor or indoor areas where chlorine or caustic are unloaded or used.

The chlorine chart describes proper procedures for unloading tank cars and ton containers, what to do in case of a leak, and first aid measures to be followed in the event of exposure to chlorine.

The caustic soda chart presents the steps for unloading tank cars of 50 per cent and 73 percent caustic and a list of safety Do's and Don't's to be observed in handling the liquid material. It also includes instructions for preparation of tank cars for the return trip to the manufacturer. Olin Mathieson Chemical Corporation.

Circle E37 on the card.

Vacuum Pumps—A new four-page, two-color bulletin, No. 403, provides a quick but comprehensive view of a line of small, air-cooled compound high vacuum pumps.

These pumps are offered in six models ranging in size from a ¼-HP unit which has a displacement of 2 CFM to a 3-HP unit having a displacement of 46 CFM. Each pump is designed to create absolute pressures below 0.2 microns (.0002 mm. Hg.), McLeod gage. Readings of 0.1 micron are typical in blank-end tests.

Bulletin 403 lists construction features of the pumps and briefly describes their operating characteristics. Complete specifications and dimensions, pumping speed curves and photographs are included for each model. Kinney Manufacturing Division, The New York Air Brake Company.

Circle E38 on the card.

Roof Ventilators Catalog—A revised catalog, Bulletin A-112A, covering roof ventilators has been published.

The catalog contains complete information on the Reversible roof ventilator as well as the Penthouse, Vertijet, Airjet and Rotary roof ventilators. Sizes, specifications, performance data and dimensional drawings are shown. Hartzell Propeller Fan Company. **Circle E39 on the card.**

Mist Eliminators—Process engineers and designers interested in economical liquid/vapor separation in chemical and petroleum plants will find this new four-page, illustrated bulletin both useful and highly informative. Bulletin No. 203 fully describes and illustrates how Schulernit entrainment separators (mist eliminators) operate, as well as various applications for separators, types of construction, and installations. Schuyler Manufacturing Corporation.

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Chemical Cleaning—A series of seven folders covering the intangibles behind Dowell's chemical cleaning service is available. They are designed to present a broad picture of the company's operations. Included is information on engineering, equipment, research, safety, service, and experience. Dowell, Inc.

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For more data on advertised products, use Readers' Service Cards, last page.

Performance Reports

Beckman GAS CHROMATOGRAPH

"...more reproducible gas analysis... in 1/10th the time."

The Beckman Gas Chromatograph, designed for the analysis of gases and low-boiling liquids, was performance-tested by two unbiased companies.

Report #1: The Beckman Gas Chromatograph "... was evaluated as an instrument for analyzing natural gas and LPG mixtures." Two different types of chromatographic columns were tested: Octoil-S and hexadecane. The Beckman Gas Chromatograph "... gave quantitative results more reproducible than those obtained by low temperature fractional analysis and required only one-tenth as much time." (See table.)

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ANALYSIS OF NATURAL GASES
Mole Per Cent

Component	Run 1	Run 2	Run 3	Run 4	Run 5	Avg	Avg Dev.	LTFD
Gas A								
Methane	83.81	83.75	83.84			83.80	0.03	82.21
Ethane	7.93	8.44	8.16			8.18	.18	9.24
Propane	5.19	5.05	5.24			5.16	.07	5.46
Isobutane	0.60	0.59	0.64			0.61	.02	0.68
N-Butane	1.53	1.43	1.40			1.45	.05	1.43
Isopentane	0.55	0.47	0.40			0.47	.05	0.98
N-Pentane	0.39	0.27	0.32			0.33	.04	
	100.00	100.00	100.00			100.00	.06	100.00
Gas B								
Methane	89.98	89.24	89.31	89.33	89.88	89.55	0.31	88.07
Ethane	5.54	5.89	5.64	5.64	5.39	5.62	.12	6.56
Propane	2.99	3.05	3.25	3.18	2.93	3.08	.11	3.49
Isobutane	0.25	0.44	0.46	0.45	0.40	0.40	.06	0.45
N-Butane	0.78	0.84	0.86	0.96	0.94	0.88	.06	0.85
Isopentane	0.19	0.25	0.25	0.19	0.22	0.22	.02	0.58
N-Pentane	0.27	0.29	0.23	0.23	0.24	0.25	.02	
	100.00	100.00	100.00	100.00	100.00	100.00	.10	100.00

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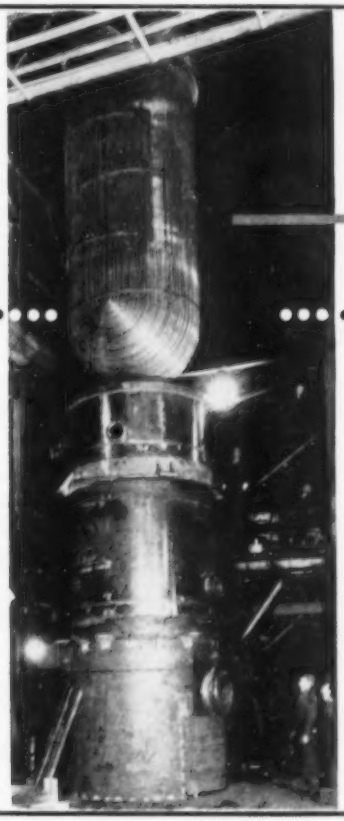

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3. Operates perfectly when pressure fluctuates

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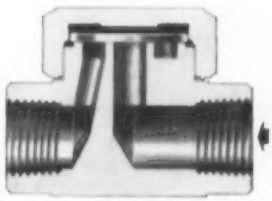

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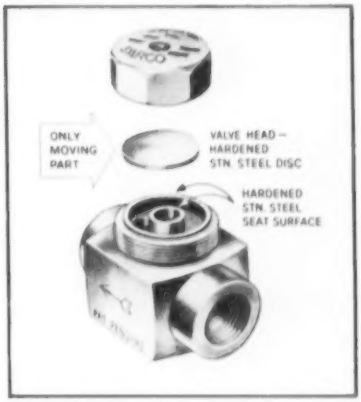
No mechanism parts to wear or stick. No narrow channels to choke. No gaskets to leak.



Maintenance practically eliminated

The all-stainless steel Sarco TD has only 3 parts...cap, disc and body. Only moving part is a hardened SOLID stainless steel disc, practically wear-proof.

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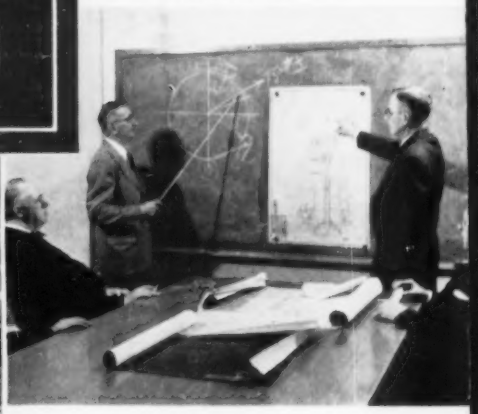

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